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The Shoshone Dam, U. S. Reclamation Service, Near Cody, Wyo.

By H. N. SAVAGE,* M. Am. Soc. C. E.

The Shoshone Dam now nearing completion is being constructed by the U. S. Reclamation Service to conserve and regulate the total discharge of the Shoshone River for the irrigation of land under the Shoshone Project in the northern end of the Big Horn Basin in northern Wyoming.

The structure is located immediately below the convergence point of the north and south forks of the Shoshone River, eight miles west of the town of Cody. The site of the dam is in a canyon of granite formation, 70 ft. wide at normal stream bed, and 200 ft. wide at an elevation of 300 ft. above the stream bed. The granite walls of the canyon continue with but little divergence from perpendicular to a height of 1,400 ft., and are in turn surmounted by a limestone capping extending to over 4,000 ft. above stream bed. Bed rock was found at a depth of 85 ft. below the bed of the stream.

The plan of the dam is a curve up-stream, with a center-line radius at the top of 150 ft.; thickness at base 108 ft., continuing uniform thickness up to stream-bed; thickness at top, 10 ft.; total height from lowest foundation, 328.4 ft. (See Figs. 1 and 2.) The unusual narrowness of the canyon, it being but 180 ft. wide at the top of the dam, and the perfect granite foundation and abutments, largely controlled the design.

The dam is being constructed of concrete, into which there is incorporated, to the extent of 25% of the total masonry, hand-placed rock weighing from 25 lbs. to 200 lbs. The sand and broken rock for the concrete, and also the hand-placed rock, is all of the first quality of granite, quarried locally and reduced by breaking and crushing to the required sizes.

An ample spillway (Figs. 1 and 8) located on the left side of the reservoir just above the dam, is obtained by excavating along the canyon wall, forming a lip 300 ft. long. The top of the lip is 10 ft. below the top of the dam. Back of the spillway lip a trench has been shot out of the canyon walls. This trench converges and deepens to a tunnel, into which it discharges. The tunnel is 20 ft. square in section, 500 ft. long, and discharges into the canyon below the dam.

The outlet works from the reservoir consist of a tunnel 10 ft. square in section by 500 ft. long, located at the stream bed, and driven around the end of the dam through the right canyon wall. The tunnel, in addition to a straight-way intake portal at stream bed, has a side intake adit which discharges through the roof of the tunnel. The portal of this adit is 20 ft. above the stream-bed portal. The discharge through the outlet tunnel is regulated by a battery of three gates, each 3 × 7 ft. clear opening. The controlling works for the gates are installed in a chamber excavated in rock immediately above the tunnel. Entrance to the chamber is through an adit from the canyon, immediately below the dam. Each gate is operated by means of an independent cylinder, the gate-stems being extended into the cylinder and fitted with a piston which is moved by pumping oil into the cylinder above and below the piston—the pump being driven by a gasoline-engine-actuated electric motor (see Fig. 3). The pump is also fitted for hand operation.

Through the body of the dam are placed two lines of 42-in. cast-iron pipe, located practically at stream bed. The outlet end of each pipe is fitted with two 30-in. pipe gates, set in Venturi.

A second outlet tunnel, with an area of 80 sq. ft. and a length of 300 ft., is being driven through the canyon side around the right end of the dam above the lower discharge tunnel, at an elevation of 110 ft. above stream bed. This upper tunnel will serve three purposes: flood discharge, supply for two high-level canals on either side of the canyon, and for power development.

The elevation of the outlet tunnels will obviate the necessity of operating any of the discharge works from the reservoir under a head greater than 110 ft.

Power may be developed through the medium of the two 42-in. pipes. The upper outlet tunnel is also located with reference to the installation of a power plant at a site 500 ft. below the dam, to develop all the power available from the reservoir. Additional power can be had by continuing the upper tunnel down-stream, gaining upwards of 50 ft. head per mile.

The reservoir created by the Shoshone Dam has a storage capacity of 460,000 acre-feet. This reservoir will have sufficient capacity to conserve, regulate and make available during the limited irrigation season the entire discharge of the Shoshone River, which exceeds 1,000,000 acre-feet annually. The drainage basin above the reservoir has an area of 1,380 sq. miles, and includes the east slope of the "crown of the continent." A portion of the drainage area lies within the Yellowstone National Park.

The maximum discharge of the river occurs during the period of maximum irrigation requirement. Storage is required to supply water to the lands after the flood has passed at the end of one irrigation season, and before the beginning of the flood discharge at the beginning of the next.

The lands flooded by the reservoir were about half in public ownership and half in private ownership. Amicable settlement without condemnation has been arranged with all the private owners and the United States has secured title to all the lands to be overflowed.

LOOKING UP THE CANYON OF THE SHOSHONE RIVER TOWARDS THE SITE OF THE SHOSHONE DAM, NEAR CODY, WYO.
(The suspension bridge is about on the center line of the dam.)

*Supervising Engineer, U. S. Reclamation Service, in Charge of Northern Division; Helena, Mont.

Before construction work could be commenced it was necessary to build a highway from Cody, the nearest railway station, up the Shoshone River through the canyon to the dam site. The perpendicular granite walls of the canyon made the construction of this road unusually difficult and expensive, and the resulting highway is one of the most spectacular in the United States. This reach of road, together with the extension recently constructed around the reservoir above the flow line, completes a national highway between Cody, the present terminus of the Chicago, Burlington & Quincy Railway, and the Yellowstone National Park, making one of the most scenic entrances to this famed resort.

Contract for the construction of the dam was entered into by the United States with the firm of Prendergast & Clarkson, September, 1905, for the estimated quantities at the following prices:

Concrete, base of dam.....	19,000 cu. yds.	$4.75	$90,250
Concrete, portion dam above base	50,000 " "	4.00	200,000
Outlet tunnel, 10 x 10 ft., concrete lining.....	480 " "	36.00	17,280
Temporary diverting works dam, 12 × 200 ft.; flume, 9 × 13 × 1,300 ft.....			37,000
Excavation foundation dam, Class 1.....	32,000 cu. yds.	$1.60	51,200
Excavation foundation dam, Class 2.....	3,000 " "	2.50	7,500
Excavation foundation dam, Class 3.....	1,000 " "	3.50	3,500
Excavation foundation dam, Class 4.....	6,000 " "	2.00	12,000
Spillway, open-cut excavation	28,000 " "	1.95	54,600
Spillway, tunnel excavation	7,000 " "	5.50	38,500
Road tunnel	150 ft.	26.00	3,900
			$515,730

The United States furnishes the cement, delivered at Cody station, eight miles from the dam. The price bid for concrete included hauling the cement, quarrying, breaking and crushing granite rock for sand, broken rock and rock for hand placing and imbedding the "plums" in the concrete. The price bid for the foundation excavation included unwatering the bed upstream.

The U. S. Fidelity & Guaranty Co., of Baltimore, Md., took over the work in August, 1906, and prosecuted it until February, 1908, when it was turned over by them to Grant Smith & Co. & Locker, who are now carrying it on. At the present rate of construction, and with favorable climatic conditions, the dam should be completed by Dec. 31, 1909. Mr. D. W. Cole, M. Am. Soc. C. E., is engineer for the U. S. Reclamation Service at the dam.

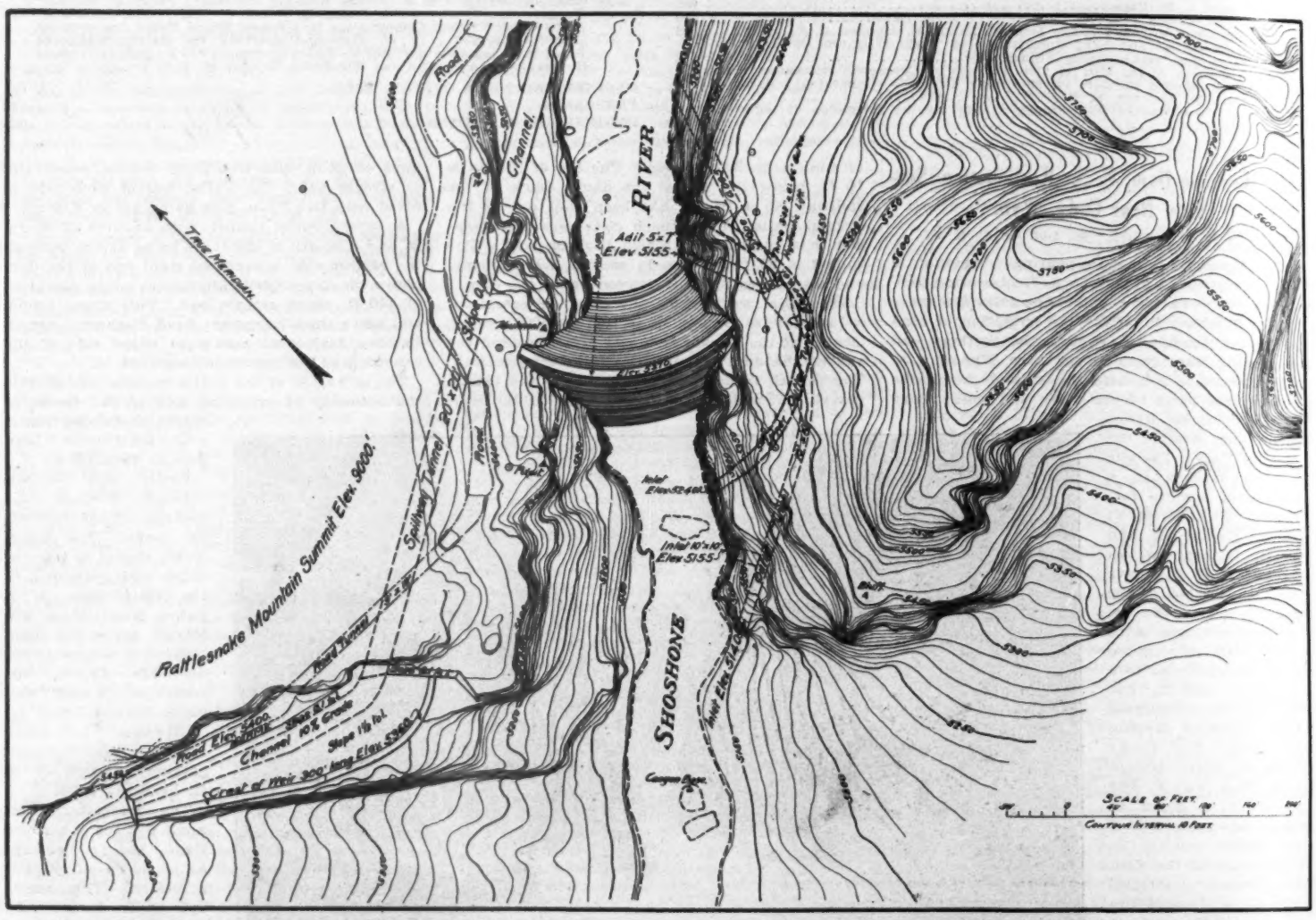

FIG. 1. GENERAL PLAN OF SHOSHONE DAM AND VICINITY, SHOSHONE PROJECT, U. S. RECLAMATION SERVICE, NEAR CODY, WYO.

[Besides the illustration mentioned in Mr. Savage's text we have selected the following from those sent by him: Fig. 5, to show the character of the natural rock forming one of the abutments of the dam; Fig. 6, to show the construction-plant lay-out, and Figs. 7 and 9, views for the further illustration of the construction plant.

Mr. Savage informs us by a telegram dated Dec. 5 that the dam had then reached Elev. 5,322, or 27 ft. above the level of Nov. 12, shown by Fig. 2 (p. 629); also that only 6,000 cu. yds. of masonry were then required for completing the dam.—Ed.]

PEAT FUEL FOR LOCOMOTIVES has been unsuccessfully experimented with by engineers of the Swedish federal railways. According to reports the fuel has proven too soft to form a proper fuel bed when fired alone, but it is expected that a type of firebox will be designed which will be more successful. If such a successful design should be evolved it is reported that the railways would place several peat-burning locomotives in regular service.

The Conservation of Coal in the United States and Its Relation to Mine Accidents.*

By EDWARD W. PARKER,† M. Am. Inst. M. E.

If one is to place any credence at all in the reports published in the daily press, the subject of conservation has been a very lively topic of conversation during the past 60 days, and it does not appear that the temperature of the summer months has been in any way moderated by the discussion. The report of the National Conservation Commission, appointed by President Roosevelt, contains a series of papers on the conservation of mineral resources, all of which were prepared by members of the Geological Survey and were compiled largely from information previously collected by that Federal bureau in the performance of its regular duties. It is not the purpose of this paper to reiterate *in extenso* any of the material already published. The contributions of the Survey officials to the Commission's report have been published in a separate document as Bulletin No. 394. This document is for free distribution and may be obtained upon application to the Director of the Survey. In the preparation of this paper I desire merely to make a few suggestions regarding the possible necessity of some restraint upon or control of one branch of the mining industry with which I have been somewhat closely associated for the past 20 years—that of coal.

Most of the members of the Institute are cognizant of the suits brought by the government against the anthracite operators in Pennsylvania, or the combination of interests commonly known as the "hard-coal trust." No defense of any illegal combination in restraint of trade is intended, but there are some facts which should not be lost sight of, and unfortunately those whose opinions are based upon the "news" given to us by the daily press are likely to be governed by *ex parte* testimony. The present situation in the anthracite region is one that has been developed through sheer necessity, if the conservation of the supply of anthracite and the prolongation of the life of the fields in the best interests of the

*A paper presented at the Spokane meeting of the American Institute of Mining Engineers, September, 1909.
†U. S. Geological Survey, Washington, D. C.

people were to be attained in any other way than through government control, and government control did not seem to be materializing. I believe that even Dr. Raymond will subscribe to the statement that a good part of the history of anthracite-mining has been one of profligate waste in the mining, preparation, and use of that precious supply of fuel; and this has only been remedied, none too soon, and could, under the circumstances, only be remedied, by the close control and conservative management which have been brought about in recent years. And I might pause here to pay a merited tribute to such men as Dr. Raymond, Eckley B. Coxe, P. W. Sheafer, Franklin B. Gowen, William Griffith, and a few others through whose efforts many reforms which lessened the waste of anthracite were effected. They were the pioneers in the battle for conservation, and a monument should be erected to them.

The securing by the Reading R. R. for its offspring, the Philadelphia & Reading Coal & Iron Co., of the great coal-reserves it owns to-day, was the beginning of a great movement which was foreseen by those in a position to see. The Reading company was temporarily bankrupted through its guarantee of the debt thus incurred, but the possession and control of those coal lands are indirectly the most valuable assets of the railroad at the present time. More than this, however, in the ultimate economy of things, has been the preservation of thousands of acres of coal-lands from reckless spoliation. The way was paved for the safe and sane control of the anthracite industry, albeit by a trust, and a stop was put to the cut-throat competition and extravagant methods which in earlier years had resulted in losses of millions of dollars in money and more than millions of tons of coal.

Under former conditions in the anthracite regions, when it was not considered necessary to give thought to the morrow, and indeed up to the time when the Anthracite Coal Waste Commission made its report in 1887, it was estimated that for every ton of coal mined and sold, 1.5 tons were lost. The greater part of this loss was in the coal left in the ground as pillars to protect the workings, while millions of tons of small coal or screenings were thrown on the culm-banks which now form unsightly mountains in the coal-regions. Improved methods of mining and of preparation have of late years reduced the percentage of waste, so that at present the recovery will average about 60% and the loss about 40%. By the means of washeries, usable coal is being saved from the old culm-banks, and specially-designed furnaces have made it possible to use this fuel in steam-plants.

It may also be possible in the future to recover a considerable part of the coal from the pillars in the old workings where they have not been hopelessly crushed by the settling of the overlying strata; but this could be done only at enormous expense compared with the present mining-cost, and when the burning of anthracite coal shall have become a luxury and permitted only to the wealthy. Even in our day and generation it is only by the strictest economy and skillful management in the operation of the mines that the price of coal to the consumer can be preserved as at present. The average price of anthracite at the mine ranges from $2.25 to $2.35 per long ton. What are known as "prepared sizes"—lump, broken, furnace, egg, stove, and chestnut—range from $3 to $3.75, and all the profit must be made on these. Pea and smaller sizes are sold at less than the cost of production, some as low as from 40 to 50 cts. a ton. A careful study of conditions in the anthracite region will convince the most sceptical that no robbery of the public is now being carried on.

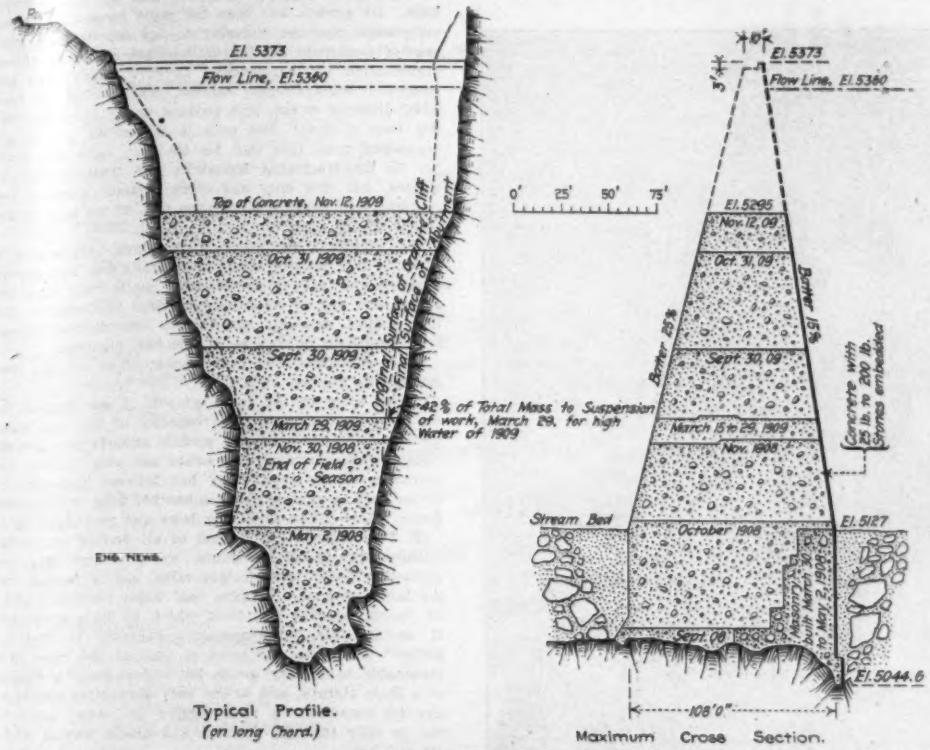

FIG. 2. TYPICAL PROFILE AND MAXIMUM CROSS-SECTION OF SHOSHONE DAM, SHOWING PROGRESS OF CONSTRUCTION TO MAY 12, 1909.

The securing of the close control or practical monopoly that exists in the anthracite region of Pennsylvania has been made possible by the comparatively limited area of the fields. The total area is less than 500 sq. miles and conditions are ideal for a natural monopoly. It is different in the bituminous fields, which are scattered over 30 different states and territories. These fields aggregate about 250,000 sq. miles in area, exclusive of approximately equal areas of lower-grade coals and lignites, and are for the most part easy of access, and do not require a very large amount of capital to develop a mine. A few thousand dollars is all that is needed at first; and as there are no restrictions on the development of new properties, every one owning land underlain by workable coal seems impelled to get it out, whether there is a profitable market for it or not.

The United States produced in 1907, the banner year of industrial activity in the United States, nearly 400,000,000 tons of bituminous coal, including about 8,250,000 tons of sub-bituminous coal and lignite. In 1908, in spite of the business depression, the production was 332,500,000 tons. We could produce from the mines already open 600,000,000 tons, and we would not have to operate the mines on Sundays and holidays to do it. If the railroads supply the cars and the motive power the mines will supply the coal. During 1907 there was, until the panic started in October, a widespread demand for transportation facilities which the railroad companies were unable to furnish. Complaints of car shortage came from practically every important coal-producing district. The transportation interests were subjected to all sorts of condemnation for failure to serve their patrons and the public, and while I am by no means a defender of the railroad companies (particularly since the Hepburn bill went into effect), it is fair to state that the inadequacy of the car supply was in reality beneficial. It is doubtful if the markets could have absorbed, even in the phenomenal activity of 1907, 5,000,000 more tons of bituminous coal, only 1.25% more than the production. An increase of 5% in the car supply and in the production would unquestionably have created a surplus and resulted in a general demoralization in values.

Notwithstanding these conditions, which are fairly well known among the coal men, new mining companies are constantly being formed and new properties opened up. The railroad companies are called upon to furnish additional switches and spurs and to provide more cars or to spread out even more thinly an already insufficient supply. As common carriers these companies cannot discriminate, and when called upon must furnish the transportation without favor. Each new mine thus opened calls for miners to work it, and miners, who are as a class nomadic, are inclined to seek employment in the newer mines. This condition reduces the supply of labor and curtails the productive capacity of the older mines; and as reduction of output means increased cost in operation, it would appear that many of these must close down as unprofitable before all of the coal that should be extracted is won.

Under our system of government and of control over mining operations any effective way of curbing the tendency on the part of coal-land owners to develop their properties or of protecting capital already invested in the industry is not apparent. The spirit of rivalry that exists throughout the coal-producing regions, district competing against district, and State against State, makes it useless to hope that State legislatures will place any restrictions upon the industry which will discourage further development. Yet every new mine opened has its influence on the creation of a surplus, which, while it may seem desirable to those who clamor for cheaper coal, is ultimately destructive of industry, lower wages, and makes necessary the practice of economies (?) that are prejudicial to safety to life and property in the operation of the mines.

The year 1907, if not the most prosperous year in the history of bituminous-coal mining, was one of the most prosperous years. Production reached its maximum, and prices were the highest in recent years. Yet there were very few districts in which the margin between the cost of putting the coal on the railroad cars and the price at which it was sold was as much as 10 cts. a ton. In many states it was considerably less than 10 cts., and this margin must cover such losses as are due to explosions and other accidents, indemnities paid to employees or their heirs, and all extraordinary expenses. One such explosion as that at Monongah, W. Va., in December, 1907, will wipe out many years' profits. In 1908 not only was the margin of profit much reduced in all the coal-mining districts, but thousands and hundreds of thousands of tons were sold at less than the cost of production. Of course, it is poor business to continue production at a loss, but a coal-mine is not a factory nor a quarry. To close down a coal mine costs money. The mine must be kept clear of water; if the ventilation is stopped, gas accumulates; falls of roof and coal occur; and after a period of idleness much repair work has to be done before operations can be resumed. It is often

FIG. 3. OPERATING MECHANISM FOR GATES OF CENTRAL OUTLET TUNNEL OF SHOSHONE DAM.

less expensive in the long run to continue the production of coal at a loss than to close down the mine.

It is, perhaps, somewhat bold to suggest that the bituminous mines should be put under some sort of government control, but if they are not, I am frankly of the opinion that before many decades have passed the protection of capital already invested will make it necessary to secure control by private enterprise of certainly

FIG. 4. HIGHWAY THROUGH SHOSHONE CANYON, BETWEEN CODY, WYO., AND THE SHOSHONE DAM.

the areas containing the higher grades of coal and to regulate the production according to market requirements. Under our system of government the Federal authorities have no jurisdiction over mines in the several States unless the power given them under the Constitution to regulate commerce between the States could be stretched to apply to coal because of its bearing on interstate traffic. But it does look as if a choice will have to be made from three evils. The first of these is the continuation of the conditions as they now exist—a feasting for to-day and remorse for the morrow. The second is the ultimate control by a combination of interests that will make the "hard-coal trust" appear insignificant—look "like thirty cents" as expressed in the vernacular—and the "water-power trust" would be of still less importance. The third is governmental supervision and regulation—not ownership, however. The first will be bad, the second worse; the third is problematical. Under such government control bituminous-coal mining could be regulated through a system of license; and in order that restriction on coal-production may be secured, no license should issue for the opening of a new mine until ample proof is shown that the necessities of the people or of trade require it.

I do not believe that present conditions should continue—they certainly must not continue if our coal supplies are going to be considered—nor do I believe that it is the part of wisdom to permit the bituminous coal supplies to get into the control of a comparatively few men living in New York and Chicago. It may be suggested that control by the several States is a fourth and best alternative. Under the competitive conditions to which I have referred it is not to be hoped or expected that the States will undertake to restrict developments in their respective jurisdictions any more than they will enact legislation which will restrict the miner in his personal liberty.

And speaking of the personal liberty of the miner, it is well known that not the least difficulty experienced in carrying on a coal-mining operation is the enforcement of discipline among the employees.

ACCIDENTS IN MINES.—When humanity is shocked by the occurrence of some great disaster in a coal-mine, sympathy is poured out to the miners and invectives hurled against the mine-owners. He is without a soul who would withhold sympathy at such a time, but scarcely less brutal is he who holds up to the condemnation of the world the ones in authority who have by all human endeavor striven to prevent the catastrophe. It is unfortunately true that the death-record in the coal mines of the United States shows unfavorable comparison with other countries, but it cannot be truly said that the blame should attach to the operators alone. In the great majority of cases they who suffer death or injury in the coal mines are victims of their own carelessness, or that of their fellow-employees.

The year 1907, the one of the greatest production in our history, was the darkest in regard to casualties, the death list exceeding 3,000. At one time an epidemic of explosions seemed to exist, and scarcely had the echoes of one died away before another occurred. The victims from this cause—that is, from explosions alone—numbered nearly 1,000, or approximately one-third of the total number of men killed. The statistics show, however, that more than that number were killed by falls of roof, most of which are preventable if proper precautions are taken by the men, or if, in fact, they obey the rules of the companies. In ordinary years the majority of accidents are due to roof-falls or to other preventable causes, but these occur singly and are not chronicled in the news dispatches. Even in the case of explosions, the cause may usually be traced, if any witnesses are alive to testify, to an act of carelessness or disobedience.

A prolific cause of mine-explosions is what is known as a "windy shot," due to an improperly-prepared blast, or to the failure on the part of the miner to undercut his coal, depending, as he frequently does, on the powder to do his work for him. Here it is that the strength of the mine-workers' union might be exercised for good, but unfortunately, instead of helping to secure legislation which will hold miners criminally responsible for acts of carelessness or insubordination that may result in loss of life or damage to property, the miners' influence is exerted against it. Such legislation means a restriction of their liberties as American citizens. If in the effort to enforce discipline a mine employee is discharged for infraction of rules, the result is, in the majority of cases, the precipitation of a strike, and the mine is laid idle for several days at least.

Coal-mining is at best a hazardous occupation, and there is no line of industry in which military discipline is so essential, except perhaps in the passenger service of railroads and steamships. In European countries, where fewer accidents occur, the operations are under strict police surveillance. Both miners and operators are made to obey the laws. When this is done in the United States accidents will decrease, but the expense of mining will be increased and the price of coal will advance. On behalf of the mine-owners, it should be admitted that self-interest, if nothing else, compels the exercise of precautions against accidents. If they have no interest in securing the safety of their employees, they have at least a desire to protect their own properties. There are instances, it is true, where operators, like the men, take chances, where false economies are practiced, and where even ordinary precautions are not observed, but these, I honestly believe, are rare, very rare, exceptions.

Coal Mine Accidents and Their Prevention.*

By J. A. HOLMES,† M. Inst. M. E.

Our coal industry in its phenomenal growth has nearly doubled during each succeeding decade of the past 60 years. It has had to do more than keep pace with our increasing population, for while it supplied less than one ton of coal per capita to the American people in 1880, it has had to supply nearly six tons per capita during 1908. Its growth has been too rapid for systematic development, and the industry to-day represents a great host of scattered, warring, discouraged elements, without organization or cooperation. In this industry are now employed some 600,000 miners, who worked at some 6,000 different mines, and produce yearly about 500,000,000 tons of coal. Not only is the nation increasingly dependent upon this coal for its heat, light and power for its manufacturing industries and transportation facilities, but this coal and other mineral products now contribute in tonnage more than 65% of the total freight traffic of the country.

The economic conditions upon which coal mining is based in this country are fundamentally bad, and the evil consequences are so far-reaching as to both time and extent and are so essentially national in character, that this subject demands the earnest consideration of our best statesmen as well as of our best engineers.

These conditions and their consequences may be summarized as follows:

(1) In spite of the rapid growth in our demand for coal, the normal productive capacity of our coal mines under continuous operation greatly exceeds this demand.

(2) Ruinous competition exists not only between the operators in the same field, but between the operators of one field as against those in another field, or in another State, where different mining laws and regulations exist.

(3) This competition is first of all driving out of the business the small operators, except where they find protection under local freight rates, and is forcing even the larger operator to mine coal under conditions which he cannot approve but from which he finds no escape. If he and his fellow-operators endeavor to "get together" and place the price of coal at the mine on a reasonable basis they go to jail under either a Federal or a State statute; and as the only alternative each must live (or succumb) by underbidding the other, which he can do only through wasteful and unsafe mining methods.

(4) Even when the demand for coal and the prices are at their best, under existing conditions, the operator can mine only that part of his coal which can be taken out

Fig. 5. Lower Portion of Left Abutment of Shoshone Dam.

[This view, together with the profile given in Fig. 2 and some of the other views, shows the remarkable character of the natural rock abutments for this dam. Note the jet of water coming in from the left.—Ed.]

most cheaply and sold at higher prices, and the remainder must be left underground in such shape as may possibly preclude its future recovery. And thus we waste yearly more than 250,000,000 tons of the Nation's fuel supply.

*Address delivered before the National Civic Federation in New York, Nov. 23, 1909.

†Expert in charge of Technologic Branch, U. S. Geological survey, Washington, D. C.

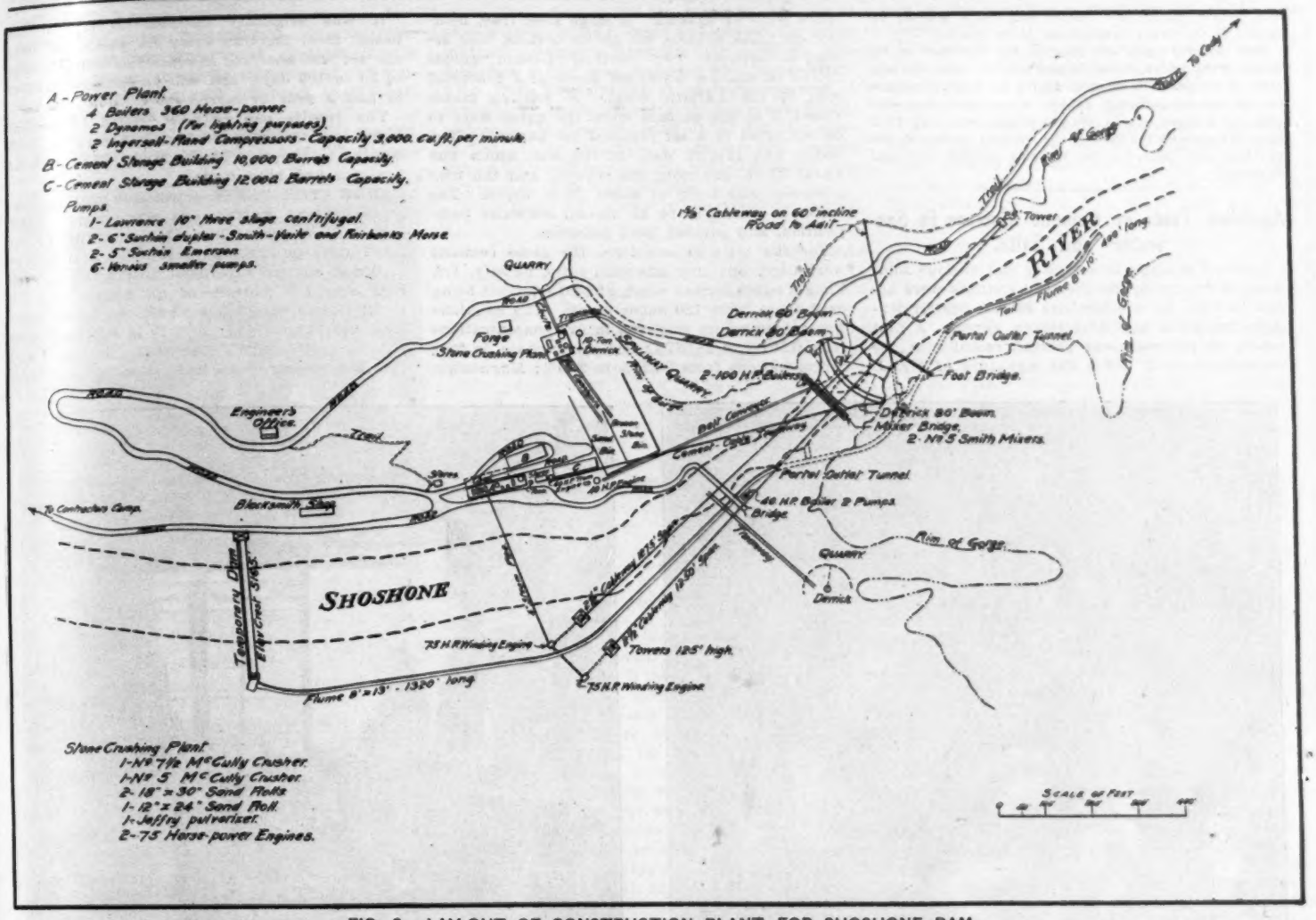
A - Power Plant.
4 Boilers 360 Horse-power.
2 Dynamos (For lighting purposes).
2 Ingersoll-Rand Compressors - Capacity 3,000 cu.ft. per minute.
B - Cement Storage Building 10,000 Barrels Capacity.
C - Cement Storage Building 12,000 Barrels Capacity.
Pumps
1 - Lawrence 10" Horse stage centrifugal.
2 - 6" Sullivan duplex - Smith-Vaile and Fairbanks Morse.
2 - 5" Sullivan Emerson.
6 - Various smaller pumps.
Stone Crushing Plant
1 - No 7½ McCully Crusher.
1 - No 5 McCully Crusher.
2 - 18" x 30" Sand Rolls
1 - 12" x 24" Sand Roll.
1 - Jaffry pulverizer.
2 - 75 Horse-power Engines.
SHOSHONE
RIVER
QUARRY
Forge
Stone Crushing Plant
Engineer's Office.
Blacksmith Shop
To Contractors Camp.
Derrick 60' Boom.
Derrick 80' Boom.
Mixer Bridge.
2 - No 5 Smith Mixers.
Portal Outlet Tunnel
Foot Bridge.
2-100 H.P. Boilers
46 H.P. Boiler 2 Pumps
Bridge.
Rim of Gorge
Tower
Flume 8'x10' 400' long
1½" Cableway on 60° incline Road to Adit
75 H.P. Winding Engine
Towers 125' high.
Flume 8'x13' - 1320' long
Tailrace Dam
Elev. Crest 5145'
SCALE OF FEET

FIG. 6. LAY-OUT OF CONSTRUCTION PLANT FOR SHOSHONE DAM.

(5) The American mine owner is as humane as is the mine owner of any other country, and he would like to follow every practice and use every appliance for safety to be found in Britain, France, Belgium, Germany, or elsewhere; but he pays his miners higher wages, and at the same time receives for his coal at the mine less than half the price received for similarly mined coal by the operator in these countries, and he must employ miners an increasingly large percentage of whom come to him unfamiliar either with the practices of the industry or with the language or traditions of the country.

(6) And the penalty which the Nation is paying for this bad system is this increasing waste of resources and the still more unpardonable increasing waste of human life—the yearly loss of 250,000,000 tons of coal, and the killing or injuring yearly of from 8,000 to 10,000 men.

And what are the remedies for this bad situation?

(a) Investigations, such as are now being conducted by the Government, as to the causes of mine explosions, and other similar investigations as to the causes of mine accidents of other kinds and as to methods of prevention.

(b) Educational work among the miners and the lower active mine officials as to these causes and remedies.

(c) The training of men at each mine as to the best method of using explosives, using electricity, handling of gases and dust, timbering, preventing and extinguishing mine fires, the methods of rescue work, and the methods of first aid to the injured.

(d) The development of better and more uniform mining laws, rules and regulations, based upon accurate data and experience.

(e) Active, determined cooperation between the miners and the mine management and the state inspectors in the enforcement of these rules and regulations with a view to the maintenance of the safest possible conditions in every mine.

The above are all parts of the program for lessening and alleviating mine accidents, but they do not complete the program. It is an essential part of this program that the ruinous competitive system upon which coal mining in the United States is based at the present time should be changed, and that the price paid for coal at the mine should be such as will permit and secure safe and efficient mining—mining unaccompanied by either this large loss of life or waste of resources—mining which can have due regard to not only the safety but also to the health and the comfort of the man who toil underground and whose labor is so essential to the welfare of the nation. All this can be done without adding appreciably to the burden of the average American citizen, without any increase in the price of coal at the poor man's cottage and without the risk of any unreasonable restraint of trade.

There can be no permanent industry without reasonable profits. It is unjust and irrational that in this great and essential branch of industry, reasonable profits should be dependent upon any unnecessary sacrifice of human life, and unnecessary waste of resources which we

FIG. 7. LOWER TOWERS FOR CABLEWAY, SHOSHONE DAM; ALSO DIVERTING FLUMES; AND SAND AND STONE BINS.

can neither replace nor restore and which will be essential to the future development of the country.

This industry needs and deserves fair treatment at the hands of the American people, and upon its receipt of such treatment depends in no small degree not only the welfare of the operators—though nobody cares about them—but also the welfare of the 600,000 miners who risk their lives in supplying the fuel for the Nation's industries, and the heat and light for the Nation's comfort and convenience.

Austrian Tests of Cement Mortars in Seawater and Salts.

Tests of cements in seawater and various solutions to determine the chemical changes were begun in 1907 by a committee of the Oesterreichische Ingenieur und Architekten Verein. A first report of progress was printed recently in the society's journal, under the signature of Mr. J. Klaudy of the committee. The investigation is chiefly by chemical analysis, but appearance is also noted.

The mortars used in these tests were molded into 32 2-in. cubes. Six kinds of cement were used, namely: A. Puzzolana (of Santorini) mixed with lime in ratio 78 to 28; B. Nine parts of this mixture and 1 part Portland cement; C. Slag cement; D. Portland cement low in alumina; E. Portland cement high in alumina; F. Natural cement. The sand used for the mortars was a specially purified quartz sand, of uniform grain.

For the sea immersion tests five mixture ratios were employed, 1:0, 1:1, 1:3, 1:6, and 1:10. The cubes were rammed into the molds by machine, and were allowed to set in air several weeks before immersion. Thirty different cubes formed a set (six cements, five sand-ratios), which was placed in a basket of leaded iron wire. There were 32 complete sets, all molded simultaneously; one full set being kept out for strength tests, there were 31 baskets. A large steel tray, holding all these baskets set on its bottom, was arranged between two vertical I-beam guides driven in shallow water off shore at a protected spot of the Adriatic coast. A hoisting tackle raised it to the surface when the cubes were to be inspected or a set removed for analysis. The water was 12½ ft. deep at the site, which was about 25 ft. out from the seawall, and the tray normally was hung at about 10-ft. depth. The water is stated to be of normal seawater composition, and without local pollution.

For the tests in solutions, the same cements were used, but only one sand-ratio, namely, 1:6. Thus 6 cubes formed a set, and 20 solutions being used there were 120 cubes in all. The solutions were: Ammonium sulphate, in five concentrations from 0.861% to 48.887%; Sodium sulphate, in four concentrations from 0.221% to 2.21%; Magnesium sulphate in two concentrations, 1.269% and 12.839%; Calcium sulphate in two concentrations, 0.082% and 0.159%; Sodium chloride in three concentrations, 3.504% to 31.941%; Magnesium chloride in three concentrations, 3.004% to 39.0%; and seawater. These were filled into half-gallon jars (one for each cube) and the jar then sealed; but many jars later burst.

The work was based on the plan of analyzing each cube as a whole, i. e., dissolving an entire cube and, after separating off the silicic acid, determining the various components by quantitative tests on separate portions of the filtrate. Special methods had to be developed for this work, on account of the large quantity of material to be analyzed as a single sample. The solvent employed was hydrochloric acid. Chlorine could not be determined, therefore. The determinations were for silicic acid, alumina, iron, lime, magnesia, sodium, sulphuric acid and carbonic acid.

It was originally intended to remove one basket from the tray every six weeks, but after one set was analyzed the intervals were changed to 50 to 100 days, and will be further increased to half a year or more.

The results can only be stated in general terms, as the time of test had been only 15 months to the date of the report. Five sets of analyses had been made.

SEAWATER TESTS.—Puzzolana mortar, puzzolana-cement mortar, and slag-cement mortar were affected most strongly, especially in the lean mixtures (1:6 and 1:10). Natural cement 1:10 also showed superficial disintegration. The neat and 1:1 mortars of all classes, the 1:3 in all classes except puzzolanic, the 1:6 in Portland and natural and the 1:10 in Portland, were still in good shape. Chemically, it was found that the mortar cubes had taken up only small amounts of sulphuric acid (sulphates), not enough to account for the disintegrating action. There was marked increase of magnesium, however, with simultaneous reduction of calcium. It is surmised that this substitution causes expansion and thereby disrupts the material. Also, there was considerable increase of carbonic acid in the cubes. The changes were rapid in the first few months, then very much slower.

TESTS IN SOLUTIONS.—The chief results were: Ammonium sulphate had the most rapid action, probably because used in highest concentrations. The puzzolanic mortars showed surface losses even in the weakest bottles, while in the strongest bottles they began to go rapidly after only 12 to 27 days. Slag cement was also very sensitive to this solution; natural cement and low-alumina Portland were better, while high-alumina Portland was best, showing a crack only after 5½ months in the 49% solution. The other sulphate solutions appeared to act about in ratio

FIG. 8. SPILLWAY WITH CONCRETE WEIR WALL, SHOSHONE DAM.
(The road above the spillway leads to Cody, Wyo., below and connects above, with the national highway leading to the Yellowstone National Park.)

FIG. 9. LOOKING UP-STREAM AT SHOSHONE DAM WHILE UNDER CONSTRUCTION, SHOWING CONCRETE MIXING BRIDGE.

of their SO_3 content, except that magnesium furthered destruction; magnesium chloride also showed moderately rapid action. Sodium chloride had but little action on the slag-cement and puzzolanic mortars, and none whatever on the natural and Portland mortars.

A special feature is that in one Mg Cl_2 solution a slag-cement cube cracked in a month, though

Fig. 1. View of Santa Monica Pier Showing Piles and Girder Bases.

in both stronger and weaker solutions of the same salt it resisted. Similarly in the seawater tests 13 out of 31 cubes of 1:6 slag-cement mortar burst or crumbled during the 15-month test period, while 1:10 cubes of the same cement showed only marked surface disintegration.

The Reinforced-Concrete Municipal Pier, Santa Monica, Cal.

By EDWIN HALL WARNER, M. Am. Soc. C. E.*

In the autumn of 1907 the question of sewage disposal in Santa Monica, Cal., a sea coast city of 10,000 people, became urgent, and it was decided to collect the sewage at the foot of Colorado Ave., treat it and discharge the effluent at such a distance from shore as to avoid the possibility of creating a nuisance. To carry the outfall pipe, a pier was proposed and plans advertised for. The writer's plans were accepted, a contract let on March 9, 1908, and work begun; although the time specified called for the completion of the structure in six months, various causes operated to delay the work, so that it was not opened until Sept. 9, 1909.

*Union Trust Bldg., Los Angeles, California.

In addition to its use in carrying the outfall pipe, sufficient width was given it to make it available as a pleasure pier. The structure is 1,600 ft. long, 35 ft. 8 ins. wide at the deck line, with three platform spaces, 43 × 89 ft. at intermediate points and end of pier. (Fig. 2.) The platform spaces were designed for the erection of sun parlors, but the revenue to be derived from other use, will probably allow the omission of this feature. Two stairways give access to the pier, one from the walk below and one along the ocean front. The earth fill, held by retaining walls parallel with the axis of the pier, and the roof of the pump house form the main approach. The floor level is 21 ft. above the city datum, which is the height of mean tide. The first bent is at practically high tide line, while the outer end of the pier has a depth of 23.5 ft. at low water.

The bents in the promenade section are of three piles, 13 ft. 6 ins. apart, and the bents are spaced 20 ft. c. to c. The long bents at the platform spaces are of seven piles similarly spaced.

The structure is divided into three approximately equal sections. In Section 1 the piles are 14-in. diameter, reinforced with six ¾-in. rods and have a jacketing of No. 10 steel 22 ins. in diam. extending from 2 ft. above high water to

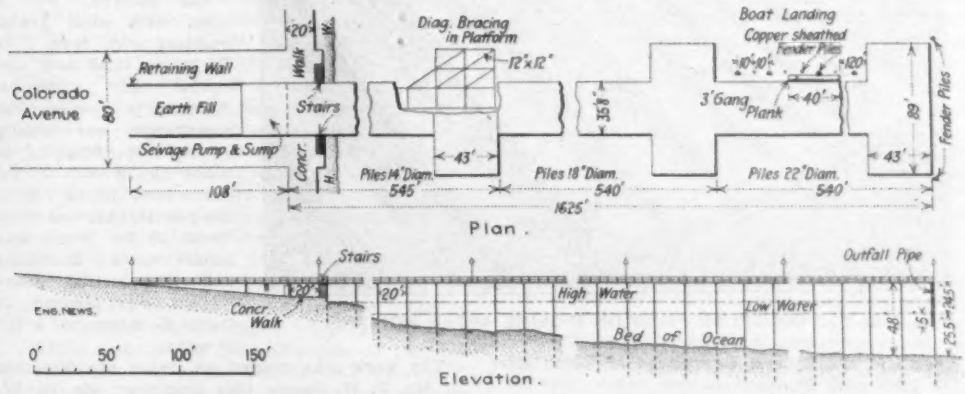

FIG. 2. GENERAL LAYOUT OF PIER, SANTA MONICA, CAL.

2 ft. 6 ins. below ground line; the space between the pile and the jacket is filled with concrete. (Fig. 3.) In Sections 2 and 3 the piles are 18 and 22-in. diam., respectively, reinforced with eight ¾-in. rods in the 18-in. and eight ⅞-in. rods in the 22-in. piles. All piles have a 2-in. wrought iron pipe cast in the center, to which the reinforcing rods are tied with No. 10 wire. They are provided with a bulb end on the bottom with a diameter of 30 ins. It was the intention to protect the piles in Sections 2 and 3 with a jacket of the same diameter as the piles, extending 3 ft. above and below the tidal range, but the prompt covering of the wet surfaces by marine mollusks rendered other protection unnecessary. The enlarged portion at the top of the piles

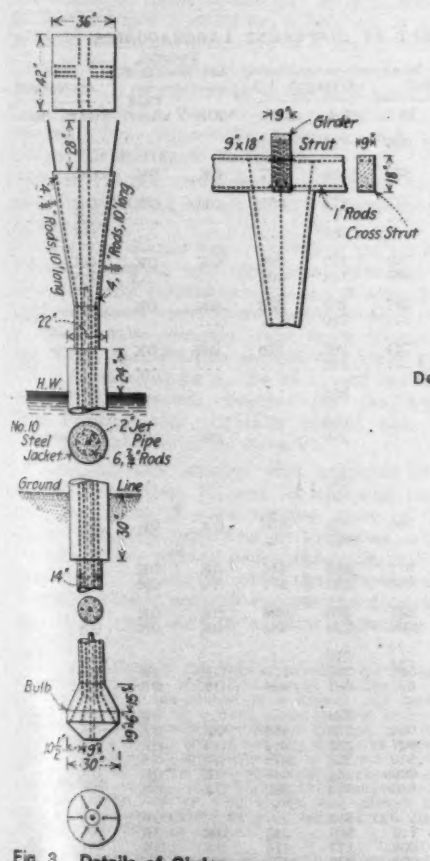

Fig. 3. Details of Girder and of 14-in. Pile With Casing.

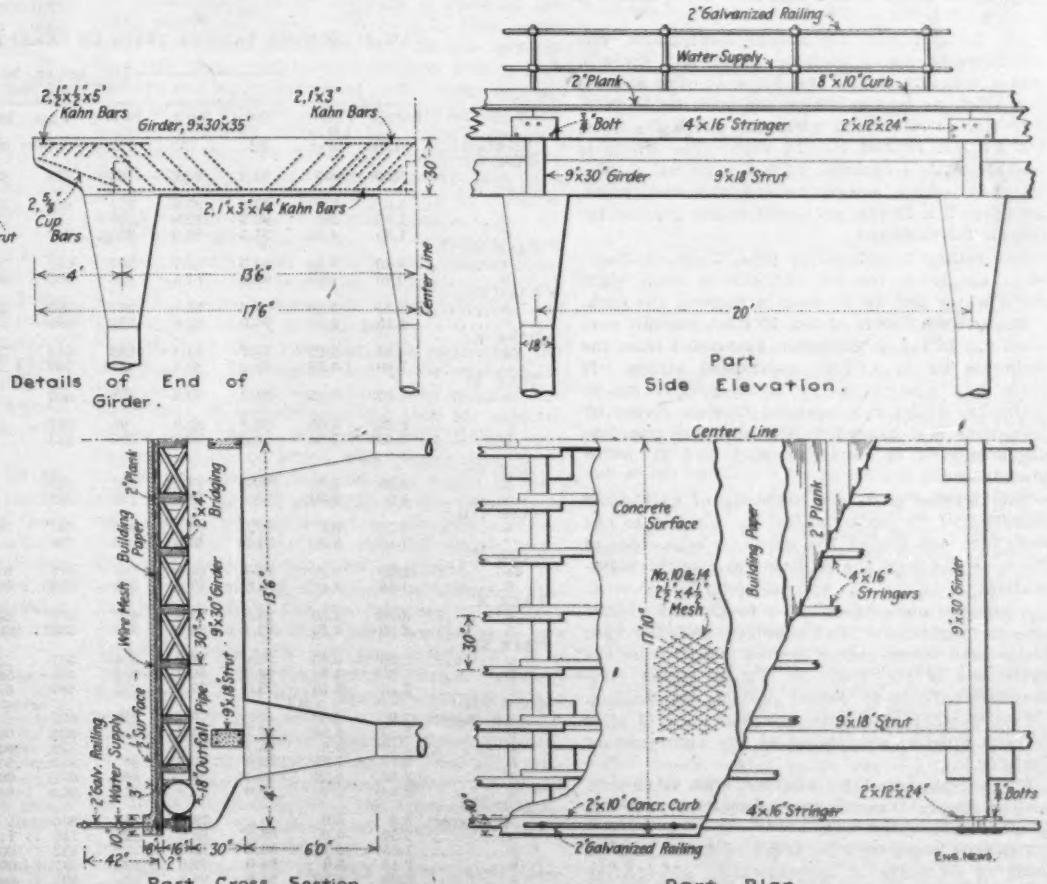

FIG. 4. DETAILS OF CONSTRUCTION, REINFORCED-CONCRETE PIER, SANTA MONICA, CAL.

FIG. 5. CONCRETE PILES ON INCLINE AFTER MOLDING.

shown in the figures, was placed in forms after the piles were driven.

The girders are 9 × 30-in. in section, 35 ft. long, and overhang the head of the pile 2 ft. 9 ins.; they are reinforced with two 1 × 3-in. bars. In the overhang are two ½ × 1½-in. × 5-ft. bars, and over the center pile are two bars 1 × 3 in. × 8 ft., all of the Kahn type.

The struts are 9 × 18-in. in section, reinforced with four rods 1 in. in diameter. In the wings of the platform spaces are diagonal struts 12 × 12 ins. in section, similarly reinforced. All pile, girder and strut reinforcement intermesh over the head of the pile.

On the girders are laid 4 × 16-in. × 22-ft. Douglas fir stringers, spaced 30 ins. c. to c. and bridged with a double set of 2 × 4-in. timbers in each bent. They are lapped on the girder, and have ½-in. tie rods passing below the girder and bolted to the stringer; the outside stringers have butt joints fished with 2 × 12-in. × 2-ft plank and four ¾-in. bolts.

On the stringers are spiked 2-in. plank, one thickness of heavy building paper laid thereon, and a concrete slab, 3 ins. thick at edge and 4½ ins. thick at centers forms the wearing surface. The slab is reinforced with wire mesh 2½ × 4½ ins. of No. 10 and No. 14 wire. The whole is finished with a concrete curb 8 × 10 ins. in section, in which are embedded the rail posts. Scuppers 2 × 10 ins. are cored in the curb at intervals for drainage.

The railing is galvanized pipe, 2 ins. in diameter; the lower rail on one side is made tight for a water line, to be used in flushing the deck.

The outfall pipe is of No. 10 steel, asphalt covered and 18 ins. in diameter, suspended from the stringers by ¼ × 1-in. galvanized straps. It turns into a downspout of ⅛-in. steel 19 ins. in diameter, which is suspended from a girder by 1-in. rods and banded to the adjacent pile; the discharge end of the downspout is 5 ft. below low water.

The lighting posts are made up of galvanized pipe, bolted to the stringers and banded to the rail; they are spaced 105 ft. along both sides of the pier and hold the fixtures for electric illumination.

A wooden gang plank on a hinge and adjustable in height by a hand windlass, affords access from small boats, and is located 200 ft. from the outer end of the pier. A row of fender piles sheathed with 18-oz. copper protects the landing.

Two clusters of copper sheathed piles (3 piles in each cluster) are placed at the outer end of the pier.

All concrete is a 1:2:4 mixture, with stone limited in size to 1 and 2 ins., respectively, for use in piles and superstructure.

The piles were built on shore in forms laid on skids at an angle of approximately 40°. After seasoning, usually for 30 days, they were picked up by a derrick and placed on cars and run out over the temporary trestle to place; here they were handled by a traveler, and jetted in place. Forms for the head were put on and filled, following which the girder and strut forms were placed and the members built.

The material was a clay, with some gravel overlaid with from 3 to 10 ft. of sand and presented only occasional difficulty in sinking. The penetration was usually 19 to 21 ft., dropping at times to 18 ft.; in the first few shore bents the penetration was from 13 to 16 ft. The material was favorable and the desired penetration was secured in from 45 mins. to 1 hr. 50 mins.

The work was carried on under the direction of Mr. T. H. James, City Engineer; Mr. H. W. Hollwedel, Resident Engineer, and the writer in a consulting capacity. The cost was approximately $100,000.

A Comparison of Reports on Tests of the Same Cement by Various Laboratories.

By ALEXIS SAURBREY.*

In a paper read before the American Society for Testing Materials, by Mr. Richard K. Meade, it is proposed to purchase cement by strength rather than by volume. The subject matter of this paper is given in condensed form in a note in Engineering News, of July 22, 1909, p. 105, where it is also stated that "this is only a suggestion and does not go into the apparently insuperable difficulties connected with the conducting of tests to the satisfaction of three different interests, viz., the cement company, the engineer and the contractor." Leaving out of consideration the first and last of these three interests, it will be shown in the following discussion that the party in the middle, the engineer, is not always easily satisfied, and that for excellent reasons. But let it be said first that the entire matter of cement testing is so vitally important to the engineering profession of our days that other writers could reasonably have been expected to have recorded similar experience, and only the absence of better evidence from other hands has compelled the writer to present the following observations from his own daily practice.

*Consulting Engineer, Cleveland, Ohio.

The letters A, B, C, D and E, as used below, refer to five different parties employed from time to time by the writer, as expert cement testers, A, B and E are local testing laboratories of good standing, C is instructor in cement testing at a large engineering college in the middle west, D is an out-of-town testing laboratory known over the entire country. The accompanying table gives the results of various reports submitted by these concerns in the course of about one year. Only cases of more than usual interest have been selected.

The first line of the table shows the standard test requirements of a Portland cement, according to the latest specifications of the American Society for Testing Materials. The time of setting is in hours and minutes. Thus: 1.5 means 1 hr. 5 min.; 2.15 means 2 hrs. 15 min.

CASE I.—This cement was sampled by A on Sept. 16, 1908. The 7-day report on neat cement is too low (Standard Specifications, American Society for Testing Materials), but otherwise the cement was normal, according to requirements then in force. The initial set when first tested by A was 3 hrs. 30 min. When testing the time of setting 3 days later, on Sept. 19, some of the cement was extremely quick setting, about 10 min. initial set. On Sept. 29, an explanatory letter was received from the mill, stating that after one-half hour in an ice-box the initial set was 38 min. The question then naturally arises: Why was all of this cement slow setting on Sept. 16, and some of it quick setting on Sept. 19? And how could A report 3 hrs. 30

TABLE SHOWING VARIOUS TESTS ON CEMENT BY DIFFERENT LABORATORIES.

			Lbs. per sq. in.							Volume, Am. Soc. C. E.			
	Set		Fineness		Strength, neat.			Strength, 1:3.				Accelerated	
Tested by.	Initial.	Final. 1.0 to 10.0	100 m.	200 m.	24 hrs.	7 d.	28 d.	7 d.	28 d.	Air.	Cold water.	Steam.	Boil.
Standard.....	0.30		92	75	175	500	600	175	250	....	....	....	....
CASE I.:													
A.....	3.30	6.0	94.4	82.6	165	324	653	159	307	OK	OK	OK	....
CASE II.:													
A.....	3.0	5.0	96.6	85.8	371	679	771	274	351	OK	OK	OK	....
B.....	1.55	3.0	93.5	82.8	179	...	...	...	...	....	....	OK	....
C.....	1.35	4.30	97.5	86.0	273	613	...	181	...	....	....	OK	OK
CASE III.:													
A.....	4.45	8.10	94.9	81.7	207	644	749	195	296	OK	OK	OK	...
B.....	0.45	1.50	93.0	81.5	168	492	585	134	391	...	...	Soft	...
CASE IV.:													
A.....	3.50	5.10	94.6	82.0	267	602	697	252	333	OK	OK	OK	...
C.....	1.15	3.10	96.0	82.0	273	641	...	190	...	...	...	OK	OK
CASE V.:													
A.....	3.15	5.25	93.7	81.4	233	614	724	261	370	OK	OK	OK	...
C.....	1.40	4.35	98.0	80.0	117	507	...	121	...	...	...	OK	OK
CASE VI.:													
A.....	4.10	6.25	95.3	82.4	231	602	...	252	...	...	...	Soft / Warped / Cracked	
C.....	2.25	4.55	96.2	82.0	90	587	...	150	...	...	...	OK	OK
D.....	4.30	7.30	94.6	79.2	359	833	...	259	...	OK	OK	Distorted / Soft	
CASE VII.:													
A.....	3.35	6.5	93.0	77.2	343	661	...	243	...	...	...	OK	...
C.....	1.5	6.20	93.7	76.4	179	601	...	154	...	...	...	OK	OK
CASE VIII.:													
A.....	3.20	6.0	95.2	81.2	325	707	799	315	436	OK	OK	OK	...
C.....	2.15	5.20	92.5	75.5	233	708	...	267	...	...	...	OK	OK
CASE IX.:													
A.....	3.30	6.25	93.4	84.8	363	677	817	383	446	OK	OK	OK	...
B.....	1.55	4.0	94.9	79.8	203	519	686	212	477	OK	OK	OK	...
CASE X.:													
A.....	3.30	5.30	94.2	83.8	420	670	687	363	428	OK	OK	OK	...
B.....	2.15	4.35	95.1	80.4	226	539	696	220	483	OK	OK	OK	OK
CASE XI.:													
B.....	2.20	4.45	95.0	80.0	208	507	...	218	...	...	...	OK	OK
B.....	2.35	4.50	94.7	80.3	202	485	597	207	475	OK	OK	OK	OK
B.....	2.15	5.10	95.0	79.7	213	495	603	207	483	OK	OK	OK	OK
CASE XII.:													
Mill Report.	3.0	5.58	....	79	290	627	...	224	...	...	OK	...	OK
B.....	2.25	4.55	92.7	78.1	211	494	611	221	484	OK	OK	OK	OK
B.....	2.15	5.5	93.1	77.0	...	476	607	215	484	OK	OK	OK	OK
B.....	2.10	5.25	92.9	76.5	207	493	612	223	478	OK	OK	OK	OK
A.....	2.30	4.50	94.4	81.4	365	694	699	284	345	OK	OK	OK	...
E.....	2.43	5.08	95.0	77.9	421	802	846	325	389	OK	OK	OK	OK
CASE XIII.:													
Mill Report.	3.3	6.0	....	79.0	284	690	...	255	...	...	OK	...	OK
A.....	2.50	4.30	95.2	82.5	429	748	710	302	343	OK	OK	OK	...
B.....	1.55	4.25	94.9	75.4	...	482	608	177	416	OK	OK	OK	OK
B.....	2.15	5.0	94.0	77.0	195	482	609	225	479	OK	OK	OK	OK
A.....	2.30	4.50	94.8	81.8	325	691	696	272	380	OK	OK	OK	...
E.....	2.43	5.5	96.5	77.5	404	786	877	306	417	OK	OK	OK	OK

min. when it took one-half hour, a few days later, to chill the cement sufficiently to give an initial set of only 38 min.?

CASE II.—After this experience it was deemed expedient to have the next shipment for this job tested by several different parties. The results are surprising. The initial set varies from 1 hr. 35 min. to 3 hrs. 0 min., the final set from 3 hrs. to 5 hrs., the fineness from 93.5 to 97.5 and from 82.8 to 86.0. With the results varying so much on the comparatively simple tests for set and fineness, it was only natural that the reports on strength of neat cement after 24 hrs. should be by A, 371; by B, 179; and by C, 273; while A and C report 274 and 181 respectively on 1:3 mortar after seven days!

CASE III.—In this case, A and B were employed to take individual samples from the same shipment, in the hope that some mistake might have entered into the reports submitted in Case II., and that they might be able to agree on this shipment. The results were not encouraging, all the figures varying in the absurdest manner. While the strength varies greatly, the time of setting varies still more, and in the accelerated tests, A's sample was O. K., B's sample soft. The writer then called on C to take out samples of 16 bags and examine each of these individually for setting. His report is given below *in extenso*.

Bag No.	Accelerated Pat. Test.	Time of set—Initial, hrs.	min.	Final, hrs.	min.
1	Hard, sound	1	0	3	5
2	Soft, left glass, slightly warped	3	5	4	0
3	Hard, sound	1	10	3	20
4	Hard, sound	0	45	2	30
5	Hard, sound	0	45	2	45
6	Hard, sound	1	0	3	5
7	Hard, broke glass, slightly warped	1	5	2	50
8	Hard, sound	1	45	3	0
9	Hard, sound	0	45	2	50
10	Hard, left glass	1	0	3	15
11	Hard, glass broke	1	0	3	0
12	Hard, glass cracked	1	5	3	0
13	Hard, sound	1	10	2	55
14	Hard, glass cracked	1	0	2	50
15	Hard, sound	1	50	2	35
16	Hard, left glass	0	55	2	45

The samples were all taken and tested in the writer's presence. No comment will be made here upon the results, which are submitted for the benefit of those interested. It is a mystery to this date how A could get a final set of 8 hrs. 10 min., while C's maximum is 4 hrs. 0 min.

CASE IV.—Individual samples were taken by A and C. It is surprising to see how close their reports come on fineness and strength of neat cement. Time of setting, however, and 7-day test on 1:3 mortar do not agree.

CASE V.—The two reports submitted do not agree in anything except in the accelerated and volume test.

The entire matter was now taken up with the parties interested, who were made familiar with the constantly varying results, and it was agreed that as soon as opportunity should present itself, A should take samples, mix these thoroughly and divide the resulting sample into three parts, one to be sampled by A, one by C, and one by an out-of-town concern selected by the writer. This program was faithfully carried out, with the results shown under Case VI.

CASE VI.—The samples were prepared as described under Case V., and in this way reports from A, C and D were secured, each of these parties therefore reporting on the same sample. No two of the reports agree except in rejecting the cement. A and D reject the cement on the accelerated test, while C reports the accelerated test O. K., but says in a letter regarding this test:

> You will note that the tensile strength at the age of 24 hrs. is very low. After I had made this test, I placed the remainder of the cement in a drawer and spread it out, and at the end of a week made another 24-hr. test. The average of these briquettes was 204 lbs. per sq. in. I also made a further test of Lot No. 6 (in this paper referred to as Case V.) after exposing to air for two weeks and found that for the 24-hr. test this lot showed a tensile strength of 265 lbs. This would indicate to me that the cement had not been stored long enough before shipping and may explain in part some of the discrepancies in the different tests.

This letter, of course, does not explain why C accepted the cement on the accelerated test, while the two other parties rejected this very same cement, but in a personal interview, C admitted that he had not made the accelerated test on the cement until after one week after receiving the sample. Now, if the cement was green, as surmised by C, this will explain the discrepancy in the accelerated test, because the seven days intervening sufficed to make the cement normal when tested for soundness by C. Yet it remains impossible for us to explain why C reported a strength of 90 lbs. of neat cement after 24 hrs. while A had 231 and D had 359. It will be seen, then, that dividing the samples as described and submitting identically the same samples to different parties, does not eliminate the discrepancy between their results. This point will be further illustrated below.

CASE VII.—The two reports made on different samples of this same shipment agree fairly well on fineness and final set. Otherwise, they simply confirm the observations made above.

CASE VIII.—These two reports, made on different samples of the same shipment, agree remarkably well on neat cement, 7-day test. Aside from this one instance, the reports are entirely different.

CASES IX.-X.—The two reports on Case IX. are made on the same sample. The two reports on Case X. refer to the next shipment of the same brand of cement as in Case IX., the interval between the two shipments being about one week. When we compare the reports from A and B in either case, they are found to agree badly, if at all. When, on the other hand, comparison is made between A's reports on IX. and X., or between B's reports on the same two cases, it is quite evident that the two shipments are very much alike, and, moreover, that A and B have adhered closely to their customary way of testing in both cases. The discrepancy must therefore be due to a difference between conditions in the two offices, whether temperature, machinery, "personal equation," or something else. This is also clearly evident from the next case.

CASE XI.—On May 22, 1909, B sampled a car load of cement, leaving a duplicate sample in the writer's office, according to the usual practice of this office. In a number of cases, these duplicate samples have been submitted to other parties for examination, as for instance in some of the cases mentioned above. On June 2, 1909, however, the sample taken on May 22 was divided into two parts, which were marked with a new number and again submitted to B. The three reports in this case are therefore made on the same sample, although the two last reports are six days later than the first. The reports all agree reasonably closely and seem to prove that each office has its own individual way of testing, which always gives comparable results, while results from different offices, as a general rule, cannot be compared. This is also clearly illustrated in the last two cases, which are also the most interesting, inasmuch as six different reports are on record in each case.

CASE XII.—The material man submitted the mill report. B sampled and tested the cement three times. When the cement was sampled the third time, E was present and took his samples of the same bags. B's sample was divided into two parts, one of which was turned over to A. It may be assumed that the mill report is none too low, as the mill certainly has no inducement to make an adverse report on its own product. Reports much higher than the mill report must, therefore, be regarded with suspicion. A's report is questionable, E's report is absurd. This also appears from the low increase in strength from 7 days to 28 days, very noticeable in A's report. If the tests had been continued for a longer time, the final results would probably have agreed quite well. The 1:3 mortar does not seem to vary quite as much as the neat cement. It is peculiar, however, that A's report (28-day) on 1:3 cement, is the lowest of them all, while his neat cement is the second highest. It might be noticed in passing that the difference in fineness between the highest and lowest report is 6.3 points on the 200-mesh sieve.

CASE XIII.—The remarks made under Case XII. may also be repeated word for word in Case XIII. A and E submit high figures, much in excess of the mill report. A's two reports do not seem to agree at all, B's reports are close together on neat cement and disagree on 1:3 mortar. It should be noted that A's first report shows a decrease in strength from 7 to 28 days on neat cement. In a letter covering this point, they say:

> We have re-determined the tensile strength of the 28-day briquettes, and find that our first result of 710 lbs. is correct. Our re-tests show 711 and 700 lbs.

It seems, indeed, that the 28-day test is about correct and that the 7-day test is too high. If we accept the more conservative figures submitted by B as approximately correct, it will be seen that A's figures have a tendency to approach B's with increasing age. E's figures, of course, are entirely wrong. The greatest variation in fineness on 200-mesh sieve is 7.1 points.

Perhaps it would not be fair to generalize from these purely local affairs. Perhaps even tests extending over a longer period would give more satisfactory results. On the other hand, the parties involved all knew that their results would be checked, and the discrepancies have been discussed so many times and caused so much confusion that the writer believes that they all tried to do their best. The conditions described are aggravating and annoying, more particularly so because the rejection or accepting of the cement in some cases depends entirely upon who happens to test the cement, and not upon the merits of the cement itself.

HEAT LOSSES IN A POWER PLANT.—Mr. F. H. Carson, Assoc. M. Inst. C. E., is the author of a paper, published as an excerpt from the Proceedings of the Institution, 1908-9, on "An Investigation of Heat Losses in a Power Station." The works under test comprised two stations, each of 2,300-KW. capacity, on adjoining property and run in conjunction. One station has nine high-speed, reciprocating, direct-current units of 120 to 550-KW. capacity, three similar alternating-current units of 60 to 200-KW. capacity, six Lancashire boilers with sprinkling stokers, and two economizers. The second station has three 775-KW. high-speed reciprocating-engine units, six Lancashire boilers with sprinkling stokers, etc. The tests reported were made during 168 hours in November, 1907, and the heat balance is summarized as follows:

Heat energy in the coal (as used).	B.T.U. 6,287 × 10³	Percentage 100
Converted into useful work	339 × 10³	5.39
Rejected to chimney	842 × 10³	13.36
Radiation and leakage from steam pipes	135 × 10³	2.15
Rejected in hot ashes (combustible)	256 × 10³	4.07
Losses (net) by auxiliary processes	189 × 10³	3.10
Rejected (net) in condensing water	3,187 × 10³	50.62
Rejected by blow-down valves of boilers	8 × 10³	0.13
Evaporating and superheating grate jets	87 × 10³	1.38
Losses unaccounted for (radiation of boilers, brickwork, including errors of observation) being balance	1,244 × 10³	19.80
Total	6,287 × 10³	100.00

A REINFORCED-CONCRETE STAND-PIPE 30 ft. in diameter and 90 ft. high has recently been completed at Empalme, Sonora, Mexico, for the Cananea, Yaqui River & Pacific R. R. Co., a part of the Southern Pacific System. The wall of the tank varies in thickness from 10 ins. at the bottom to 5 ins. at the top, and is reinforced with two rows of vertical ½-in. sq. rods spaced 10½ ins. c. to c. and with two sets of horizontal circumferential rods varying from ¾-in. sq. spaced 2¾-in. c. to c. at the bottom to ⅝-in. sq., spaced 3½-ins. c. to c. at the top. Around the bottom 4 ft. there is an extra curbing which increases the thickness to 18 ins. for that height.

A 1:2:3½ mixture of concrete was used. As the sand used contained some adobe it was thoroughly washed before using and great care was taken to get stone of proper size. The concrete was mixed with a percentage of patented waterproofing compound. After placing, the concrete was allowed to set four months before water was let in. At first, according to information we have received from the Chief Engineer of the railroad, the entire outside surface of the wall was wetted by the pressure of the water and a white efflorescence appeared, especially along the planes where concreting stopped. In the course of six weeks the wall gradually dried out, probably because the pores became stopped up with sediment. At present, the outside is perfectly dry except for one small spot in the base near the ground line where there is a slight sweating, but it seems that this hole, too, is being gradually filled.

Design for Concrete Dry-Dock at Pearl Harbor, Hawaii, for the United States Navy.

By R. E. BAKENHUS.*

A first-class naval base is being built by the Navy Department in the Hawaiian Islands about seven miles west of Honolulu on the southern side of the island of Oahu. The site selected is at Pearl Harbor and is one of the finest in the world for the purpose, having an ample harbor which is sufficiently far inland to be secure from attack. The five-mile channel to the sea is already being improved by dredging at a cost of $3,500,000. The climate is remarkably equable and favorable to the conduct of work. The annual variation in temperature is about 30° F., with a maximum temperature of 85° F. During most of the year the trade winds blow from the northeast. All in all, the conditions seem almost ideal for the establishment of the proposed station.

The new concrete dry-dock now being built, for which plans and specifications were prepared by the Bureau of Yards and Docks of the Navy Department, will be the nucleus of the station. The amount available for the dock is $2,000,000. Its general dimensions (Figs. 1 and 2) will be such that it will take the largest battleship now built or contemplated. It will be so arranged that the length may be increased at any time to accommodate longer ships, or two ships in tandem, provided Congress authorizes the necessary expenditure. If the projected plans for lengthening (see broken lines in Fig. 3) are carried out it will be the largest dock in the world. The width and depth over the sill, which it is practically impossible to increase after the dock is built, will be great enough to cover all possible future demands, in the way of battleships. The present length will be 589 ft. from outer seat to coping at head; the proposed increased length is 1,200 ft.

The site of the dock is in coral formation, which is of somewhat irregular character. The borings show that layers of hard coral rock, soft coral rock, so-called mud, and coral sand are distributed in an unsystematic manner. There is indication, however, of a layer of rather stiff mud extending under the entire site. If this layer is continuous it will probably prove fortunate as water would be more easily excluded from the excavation. The coral rock is likely to be porous and water-bearing and while offering a firmer foundation would be probably less favorable during construction.

Concrete will form the bulk of the material to be used, the total amounting to 71,000 cu. yds. There will be about 650 tons of cast-iron in the pipes, nosings, manhole covers and drainage systems. The total excavation exclusive of dredging is upward of 200,000 cu. yds. An investigation was made of local building materials and it was found that an excellent crushed stone can be obtained from the deposits of lava rock. A satisfactory sand can be obtained only by crushing and rolling the lava rock. The coral sand is too soft and absorptive. The materials will give a heavy concrete weighing 160 lbs. per cu. ft. Cement must be imported.

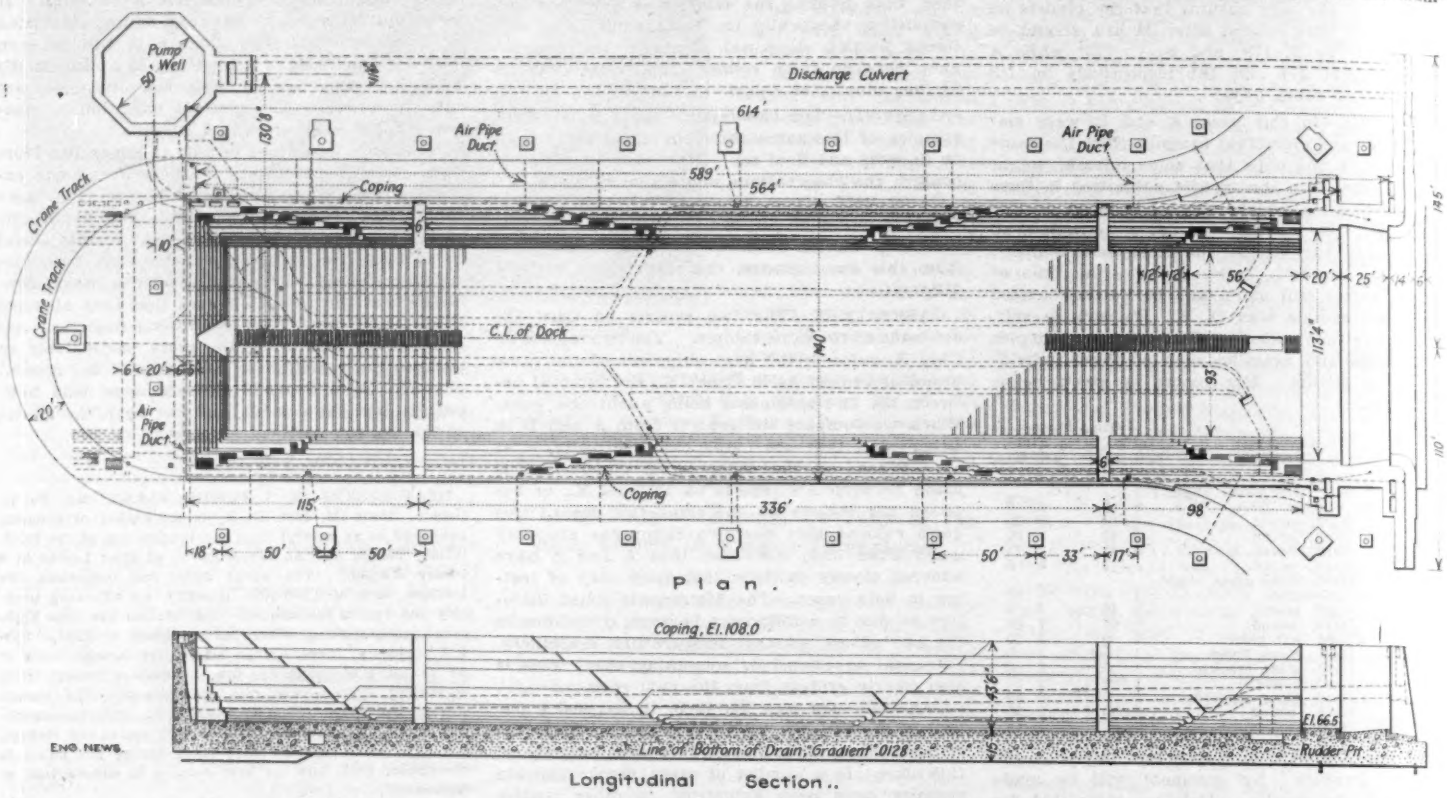

FIG. 1. GENERAL PLAN AND LONGITUDINAL SECTION OF PEARL HARBOR DRY-DOCK (PRESENT CONTRACT).

(The broken lines at the left show the location of the intermediate gate seats which will form part of the extension to 1,200 ft. See Fig. 3. The head wall of the 600-ft. dock now being built is to be removed after the extension work is all completed. The intermediate gate seats will accommodate a caisson gate like that at the entrance, and as the seats are double the inner and outer docks can be used separately or together.)

Design of the Dock.

FUNCTIONS.—It may be of advantage to state here briefly the fundamental features of the dry-dock. It is a closed basin having a gate at one end and a pumping plant. With the dock full of water the ship is floated in and the gate closed. Thereupon the water is pumped out and the ship settles down on a series of timber blocks. The entire bottom of the ship is thus exposed for cleaning and repairs. After completing work on the ship, water is allowed to flow into the dock and when full the gate is removed and the ship floated out. It is necessary that all these operations be performed rapidly, since the time of the working force and ship's crew is valuable and above all in war time occasion may arise when docking must be carried on with the utmost speed.

STRUCTURAL ELEMENTS.—The problems involved in the design of a dry-dock are manifold, as may be readily seen from an outline of the structural elements. The side walls of the dock basin act as retaining walls, with a continuous earth pressure on the back and a varying water pressure on the front as the dock is full or empty. The inside faces of the side walls have altars or steps which are working platforms for the men during the docking operations. The floor of the dock carries the load on the timber blocking to the foundation and takes the thrust at the toe of the side walls. With an empty dock the combined dead weight of the floor and side walls, aided by earth friction on the side walls, must be capable of resisting the upward hydrostatic pressure on the foundation. The entrance to the dock must be sufficiently wide and deep to admit the largest ship which the dock body can accommodate and must provide one or two seats for the gate. The gate

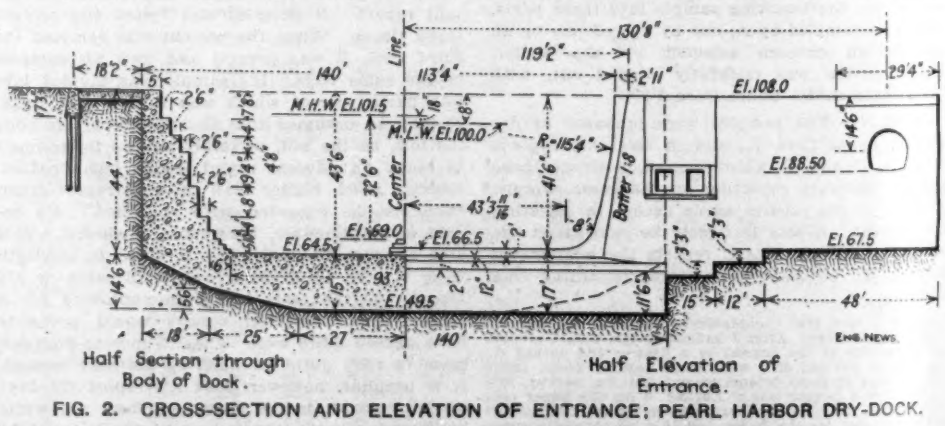

FIG. 2. CROSS-SECTION AND ELEVATION OF ENTRANCE; PEARL HARBOR DRY-DOCK.

*Civil Engineer, U. S. Navy; in charge of design of Pearl Harbor Dry-dock.

seats must transmit to the side walls the enormous water pressure on the caisson. The head forms the closure of the basin at the inner end and its shape is important as affecting the cost of the dock, facilities for future lengthening and the number of small ships that may be accommodated side by side. The caisson, or gate, forms the removable closure at the sea end. The floor drainage system carries the water to the pump chamber. The pumping plant draws the water from the dock and discharges it overboard.

The severest stresses occur when the dock is empty, and the earth and water pressures are acting on the sides and full hydrostatic pressure on the bottom. The intensity of the upward hydrostatic pressure is uncertain, but under normal conditions should be taken as that due to a head equal to the height of normal groundwater, giving about 3,600 lbs. per sq. ft. at Pearl Harbor. The pressure on the side walls is due to combined earth pressure, water pressure and surcharge.

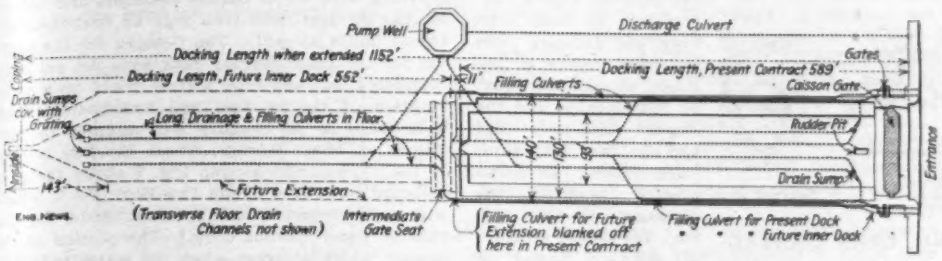

FIG. 3. SKETCH PLAN OF PRESENT CONTRACT FOR PEARL HARBOR DRY-DOCK AND PROJECTED EXTENSION, SHOWING LOCATION OF DRAINAGE AND FILLING CULVERTS.

(The shape of head for the 1,200-ft. dock has not yet been decided on. A V-shaped head is shown, but it is equally probable at present that a square head, like that of the short dock, or a trapezoidal head may be used.)

These features will now be described more fully as actually embodied in the plans for Pearl Harbor Dry-Dock No. 1.

SIDE WALLS AND FLOOR.—The cross-section of the dock (Fig. 2) as defining the contour of the working space and affecting the cost is its most vital feature. Accordingly careful study was given to this point in the Pearl Harbor dock. The floor is level, which affords the best working surface, especially as battleships have a flat bottom. The clear width between side walls at the floor level is 93 ft.; at the top of keel-blocks 102 ft., at a point 8 ft. above the keel-blocks 105 ft., and at coping level 130 ft.

The principal altars are those which are exposed just as the ship is about to settle on the blocks, since at this time the heavy lateral shores are placed. The height of these altars is determined by the draft and range of the tide. The heights selected for the Pearl Harbor dock are 22 ft. 8 ins., 27 ft. 4 ins., and 31 ft. 4 ins., respectively above the top of keel-blocks. The remaining altars are placed at convenient heights for staging.

The depth of the floor is 43 ft. 6 ins. below the coping, which allows 6 ft. 6 ins. for distance of mean high water below coping, 4 ft. 6 ins. for height of keel-blocks and 32 ft. 6 ins. for maximum draft of ship and clearance over blocks. Formerly it was important to have the side walls far enough back from the ship to admit light underneath. With the modern wide and flat-bottom ships this is practically impossible, and artificial light is used.

The most logical method of design is to consider the side walls and floor as forming an inverted arch. The contour of the intrados is determined principally by the conditions of use of the dock, leaving the contour of the extrados to be determined from structural considerations. The lower altars form the critical point, as the stresses require them to be moved inward as far as possible and the conditions of use demand the opposite. The central portion of the arch is necessarily very flat due to the level floor and the distance between side walls. As the load on the flat portion of the arch is enormous—3,600 lbs. per sq. ft.—the design of the arch is attended with some difficulty. The only way that the difficulty may be overcome, at least so far as accepted methods of dock design go, is by making the floor so thick that the arch will have sufficient rise and so that its dead weight will directly neutralize much of the upward pressure. The 15-ft. thickness of floor of the Pearl Harbor dock weighs about 2,400 lbs. per sq. ft., leaving an upward unbalanced load of 1,200 lbs. per sq. ft., which is the net load on the arch. By selecting a proper thickness of side wall an arch is obtained having the line of resistance practically within the middle third at all points.

The total weight of the material in the cross-section is nearly equal to the upward hydrostatic pressure, showing an economical distribution.

ENTRANCE.—The entrance to the dock is slightly narrower than the dock body (Fig. 2). It is provided with two caisson seats of identical shape 20 ft. apart. Two seats cost but little more than one, and allow of repairs to one with the other in use. Also with the caisson on the inner seat the amount of water to be pumped is reduced, while the outer seat gives 20 ft. extra length. The shape of the entrance is such as to facilitate the placing of the caisson. To this end the sides are curves with the center points at the coping level, so that the caisson cannot bind if it tilts. The sill is horizontal and joined to the curved sides by a curve of 8-ft. radius. The seat itself is formed of heavy granite blocks with concrete backing.

The entrance width at coping level is 113 ft. 4 ins. At the level of the top of keel-blocks the width is 104 ft. The depth of water over the sill at mean high water is 35 ft. and at mean low water is approximately 33 ft. 6 ins. These dimensions will be more fully appreciated by recalling that the Panama Canal locks are only 110 ft. wide, and that the greatest ocean liners have a breadth of only 88 ft., and there are very few ships indeed, if any, having a light draft over 33 ft.

THE HEAD.—As an ultimate extension in length of the present dock was considered a practical certainty, the square head was selected (Fig. 1). The side walls will be built to the extreme end of the dock with all features complete and the head will be formed of a straight cross-wall of a section similar to that of the side walls. It will be a gravity wall, designed not only to withstand earth pressure from the outside but also to resist the water pressure from the dock side when the earth backing is removed during the extension of the dock. Otherwise the use of the present dock would have been interfered with during extension. Another important reason for adopting the square end is that the building of the extension to the dock, including caisson seats Nos. 3 and 4 can be entirely completed before removal of the head wall.

An arched head, while a little cheaper, would not have taken pressure in both directions. The trapezoidal head, while the most economical of all for a completed dock, would have meant greater ultimate cost for a dock to be lengthened. A V-shaped head is of course out of the question where the dock is to be extended, because of the great length necessary to be torn out in removal.

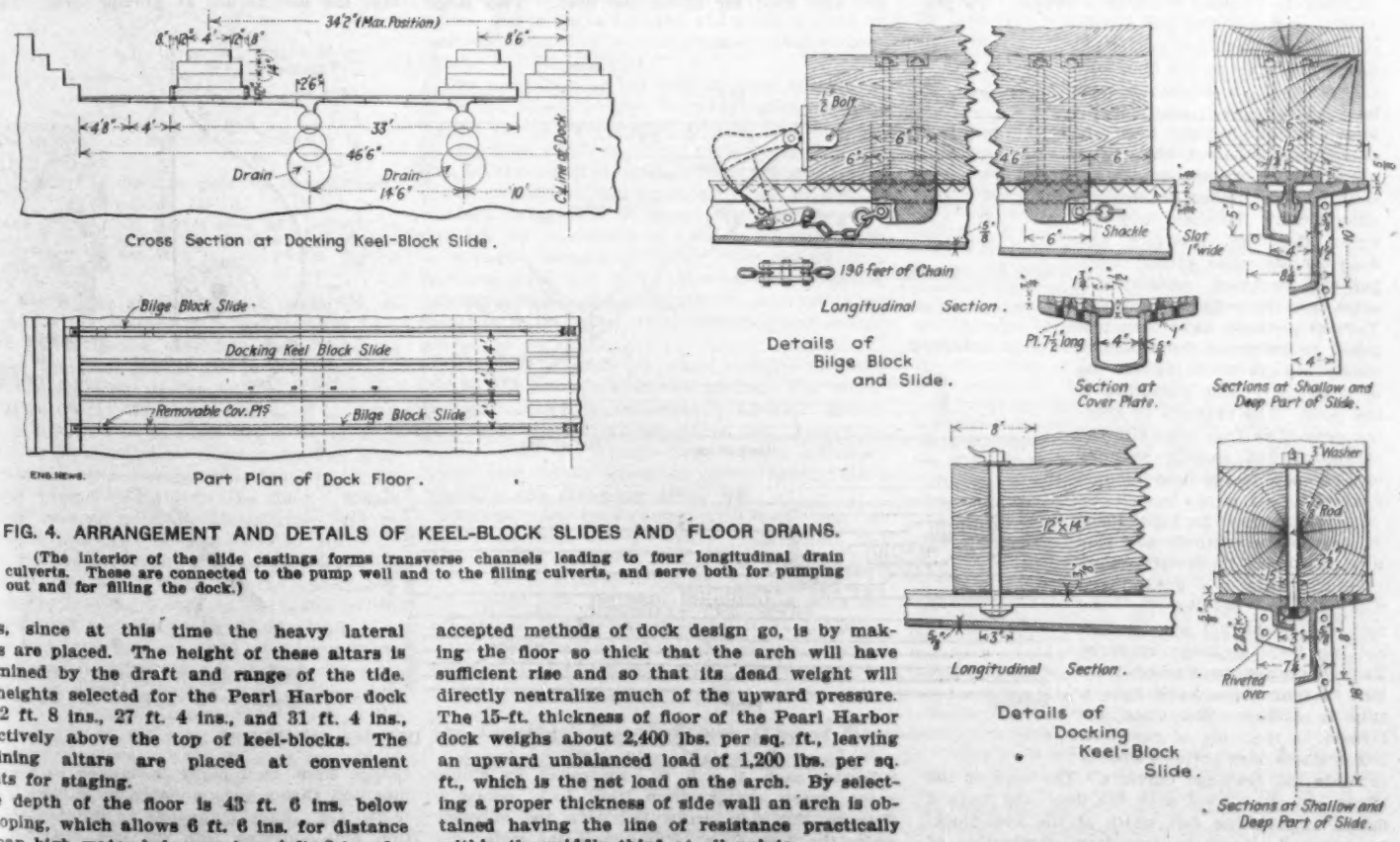

FIG. 4. ARRANGEMENT AND DETAILS OF KEEL-BLOCK SLIDES AND FLOOR DRAINS.

(The interior of the slide castings forms transverse channels leading to four longitudinal drain culverts. These are connected to the pump well and to the filling culverts, and serve both for pumping out and for filling the dock.)

A V-shaped cut is made at the middle of the head wall to take the bow of a ship. Thus at slight cost the docking length is increased about 15 ft.

BLOCKING AND SUPPORT OF SHIP.—The ship's weight is carried principally on the row of keel-blocks spaced 2 ft. on centers along the middle of the dock. To steady her, heavy shores are placed from the altars to the ship's side. In addition, with certain ships, bilge blocks with inclined tops are pulled into place and support the ship at the side.

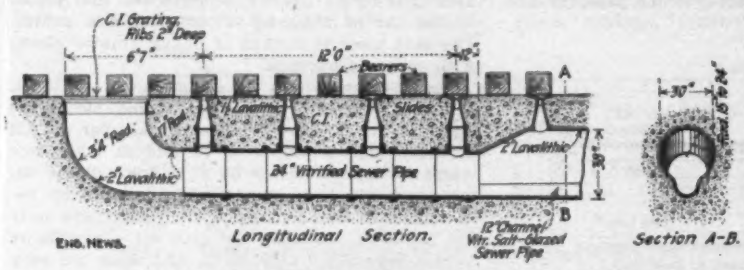

FIG. 5. DETAIL AT UPPER END OF LONGITUDINAL DRAIN CULVERT.

The modern battleship cannot be supported by these means alone. On account of the wide beam, and the great weight of the turrets, guns, etc., so-called docking keels are provided, about half way between the center keel and the sides of the ship. The docking keel-blocks take the weight from the docking keels and steady the ship without use of either shores or bilge blocks. The tops of the keel-blocks and also of the docking keel-blocks are in a level plane 4 ft. 6 ins. above the floor of the dock so that the workmen may have ample headroom. In case of a ship with unusual draft or of a disabled ship the top keel-blocks can be taken off, as the tops of the blocks are normally 2 ft. 6 ins. above the entrance sill.

As the ship's docking keels are not always the same distance out from the center keel, the docking keel-blocks must be movable. To provide a suitable bed for accomplishing this, a timber bearer has usually been set on the floor with a level top. A similar scheme has generally been used for the bilge blocks, which must be guided by the bearer while being pulled under water against the ship. These timber bearers are objectionable because they obstruct the floor, interfere with floor drainage and greatly hamper the workmen, especially on account of the reduced headroom. Various methods have been proposed to overcome the difficulty, nearly always involving the use of a guide or slot embedded in the floor. The problem of keeping such slots free from silt and scrapings has usually resulted in a recourse to the time-honored method.

In the studies for the Pearl Harbor dock an entirely new idea was developed, in devising slots that not only are guides and holding-down devices for the movable blocks but also feeders for the floor drainage culverts. They will thus be flushed from two to four times each time a ship is docked. The slots are formed in the tops of cast-iron boxes which have bottoms sloping towards the drainage culverts. The tops of the boxes are on a level with the floor and have a flange to take the full width of the keel-block. The dock floor will be free from obstruction of any kind; even the bilge-block pulling chains will be enclosed in the cast-iron boxes. Figs. 4 and 5, in conjunction with plan in Fig. 1, explain the construction fully.

FLOOR DRAINAGE.—The discussion of the slots in the floor brings up the subject of floor drainage methods. That the problem is a serious one will be realized from the statement that the floor is about 93 ft. wide and 577 ft. long, a total of 53,000 sq. ft., and that this floor must be free of water as quickly as possible after the ship is on the blocks. The old method was to provide pump sumps at one end and pitch the floor longitudinally to the sumps, or else to pitch it laterally to drainage gutters at the sides leading to the sump. Later docks were provided with sewers or culverts in the body of the floor having inlet gratings distributed at low points in the floor at regular intervals. At best, however, the distance from the high points to the inlets or gutters must be considerable and the slopes therefore flat and the flow very slow. Furthermore, the blocks greatly impeded the passage of the water. The lower stratum of water flowed to the pumps so slowly that the large pumps could not be kept going and the small drainage pumps had to be used, at a great loss in time. In the proposed floor drainage system for the Pearl Harbor dock the cast-iron slotted boxes extend entirely across the floor and are spaced 4 ft. apart. A drop of water need therefore travel only 2 ft. to disappear from the floor. The cubical content of the slotted boxes, culverts and drainage chambers is so large and the flow to them so free that there will be no difficulty in keeping the large pumps going until the water has entirely disappeared from the floor. The various waterways were proportioned with great care so that the velocity at all points would be sufficient to carry silt and debris, without at the same time producing excessive velocities at any point.

FILLING DEVICES.—The cast-iron slotted boxes fulfill another important purpose, as they are also used for filling the dock. Two large culverts, each 4 × 6 ft., controlled by sluice gates carry water from the dock entrance through the side walls and into the culverts under the dock floor. From these the water enters the risers to the transverse cast-iron boxes, whence it issues into the dock through the slots. The water thus enters the dock in an upward direction and is uniformly distributed. This allows of greatly increasing the speed of filling. Former methods of filling were by means of pipes passing through the caisson, or by culverts emptying into the sides of the dock, but a high rate of filling was not possible by these methods and resulted in dangerous currents.

CAISSON GATE.—The closure of the entrance, in conformity with the usual American practice, is effected by means of a steel floating caisson or gate. The total water pressure to be sustained is 4,600,000 lbs. or about 13½ tons per lin. ft. The maximum intensity of pressure is 2,200 lbs. per sq. ft. Not only must the caisson structure be designed to sustain the water pressure but it must also float, have stability, and be provided with water ballast chambers and pumps so that its draft and trim may be controlled between limits at will. The designs for the caisson for the Pearl Harbor dock have not yet been completed, but the type will no doubt be a combination of the fin keel and hydrometer types. This shape is particularly well adapted to conditions at Pearl Harbor, where the tide is only 18 ins. [The cross-section Fig. 7 shows the gate designed for Puget Sound Dry-Dock No. 2, which will probably serve as a general model for the gate at Pearl Harbor dock.] The portion of the caisson which emerges when the water ballast is pumped out is made as narrow as possible, so that the displacement per foot of height is a minimum and consequently the amount of water to be pumped and the time required to float the caisson are a minimum. The keel of the caisson instead of being on the middle may possibly be arranged at one side, which will afford the advantage that about 10 ft. in length of dock is saved over the center-keel type because this necessarily projects into the dock body.

PUMPING PLANT.—The pumping plant is designed to be of ample capacity to pump the dock after it is lengthened to 1,200 ft., but only two of the four pumps will be installed for the present 600-ft. dock. The well will be built to take the four pumps. The pumps will be of vertical-shaft centrifugal type with direct-connected motor drive, suction and discharge 54 ins. in diameter. The pump body is located below the floor level of the dock so as to be always self-priming; the motors are at ground level. The discharge from each pump is carried to a central pipe and thence into a discharge culvert leading to the sea. Each pump has an independent suction pipe, opening into the wet chamber, and also a lead to the opposite side of the pump well in case an adjoining dock is ever built. From the wet chamber three 54-in. pipes with valves lead into the drainage chamber underneath the dock floor, into which the culverts discharge. When the second half of the dock is built (divided from the first by a removable caisson gate) three similar 54-in. pipes with valves will lead

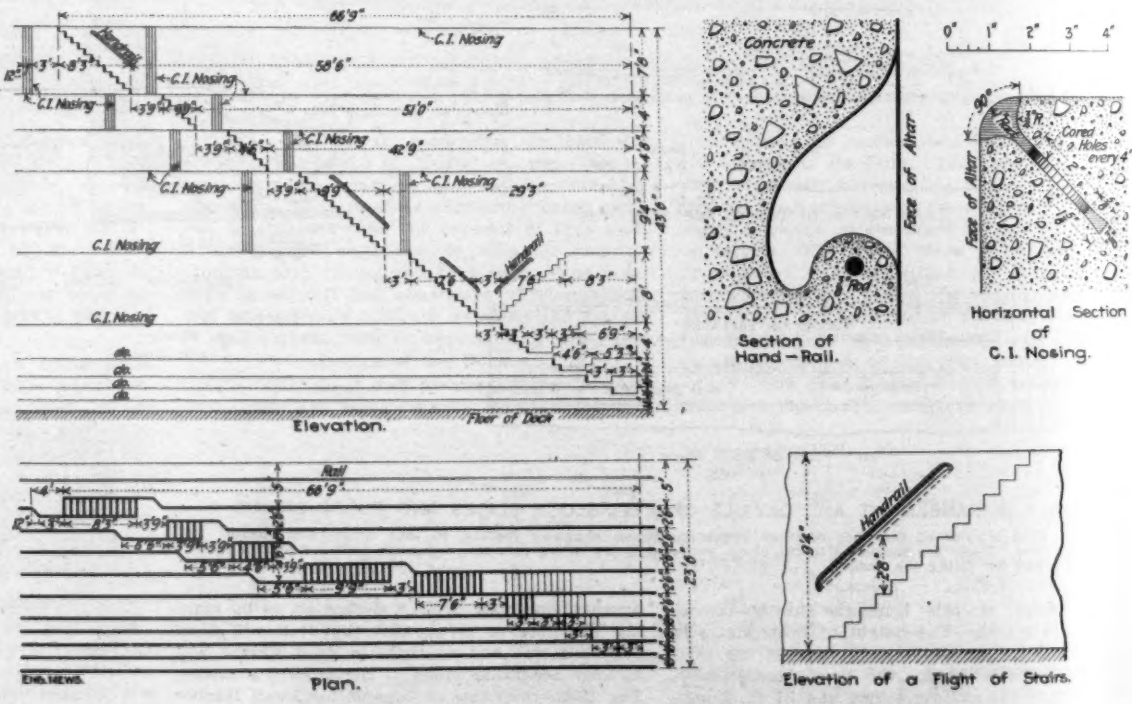

FIG. 6. TYPICAL ARRANGEMENT AND DETAILS OF STAIRS.

into it from the present wet chamber. It will then be possible to pump either the outer dock or the inner dock independently, using from one to four pumps. The system of drainage and filling culverts is shown clearly in the small-scale diagram in Fig. 1.

The leakage into the dock will be taken care of by one or two small direct-connected motor-driven vertical-shaft pumps.

The pump well is octagonal (Fig. 1). It is located at the head of the present dock, which

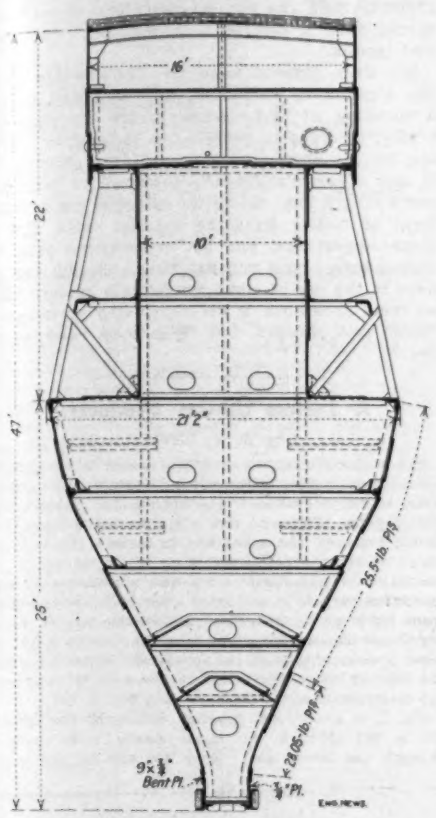

Fig. 7. Section of Caisson Gate for Puget Sound Dry-Dock No. 2.

(The gate of the Pearl Harbor dock will probably be designed to a similar outline, but the keel or diaphragm may be arranged on one side, to give greater docking length when needed.)

will be the middle of the dock as extended, so as to reduce the suction leads to the two independent halves of the extended dock, and also to reduce the total fall of the longitudinal culverts. The diameter of the well (inscribed circle) will be 50 ft. The wall will be 6 ft. thick at the bottom. The extreme depth of excavation will be 66 ft. The exterior of the well is to be surrounded by a waterproofing material which will also extend underneath the floor. Where the pipes pass through, special flanges will be provided to prevent leakage along the pipe. To protect the waterproofing on the side walls an 8-in. brick wall will be built, and the waterproofing material may be placed on the inside of the brick wall and the concrete built against it.

While it is not expected that seepage will get through the waterproofing, provision to take care of such water has been made. There will be a series of vertical earthenware pipes in the wall connected at the foot and carried to the drainage pump sump. Similar pipes are placed in the floor. The water outside the wall has a static head. In passing through the wall this pressure-head is lost in overcoming friction and becomes zero when reaching the inside of the wall. The pipes establish points of zero head *within* the wall; they are so spaced that the distance from any point on the exterior of the wall to a pipe is less than the distance to the inside face of the wall. With a reasonably homogeneous material the water would therefore all flow to the pipes.

STAIRWAYS.—The stairways are important in the daily use of the dock as they control the speed of egress and ingress of the working force. Six flights of stairs are provided for a dock 620 ft. long. The width of the stairs is 24 ins., the rise is approximately 8 ins., the tread 9 ins. and the number of risers from floor to coping is 65. The flights of stairs have been so placed that passage along the principal altars is not interrupted. To this end one-half of the width of the stair projects into the dock body and one-half is built into the face of the altar, leaving a passage of 18 ins. on the altars. A typical stairway and its chief details are shown in Fig. 6.

MATERIAL SLIDES AND CONTRACTION JOINTS.—For convenience in sliding material into the dock, when not handled by crane, four material slides are built into the side walls. These are lined with granite. The contraction joints are located at the slides, because there was already a break in the continuity of the side walls here.

The term "contraction" joint is used in preference to "expansion" joint, because at Pearl Harbor the annual variation in temperature is normally only 28° F., not enough to cause any appreciable deformation; this makes the contraction due to setting the principal factor to be provided for.

The contraction joint is formed by making a slip joint by means of waterproof layers. A small seepage pipe is built into the concrete to carry any water entering the wall from the earth, to the body of the dock.

EQUIPMENT.—The dock will be provided with seven electrically operated capstans and with an ample supply of cleats, chocks, rings, winches and similar devices.

MATERIALS.—The dock walls and floor will be of concrete composed of 100 lbs. of cement to an aggregate of 6½ cu. ft. of stone. The amount of sand is variable and is determined by experiment so as to give the heaviest mixture of stone and sand by weight. This method of mixing gives the densest possible mixture with the actual materials to be used and gives a fixed or uniform amount of cement per cubic yard of concrete.

The inner face of the dock is lined with lavalithic (so called because it is analogous to granolithic except that crushed lava is used in place of crushed granite). The proportions are 100 lbs. of cement to 2 cu. ft. of fine material. The outer surface of the dock—all that portion in contact with earth—is lined with concrete having 100 lbs. of cement to 4 cu. ft. of stone with a variable amount of sand. The richest concrete is thus put where the conditions during construction are the most severe; also the richer concrete is the more water retarding and should be on the outside.

Cast iron is used for altar nosings, drainage boxes and for miscellaneous piping. For blocking any one of the following is allowed: American rock elm, American white oak, Australian tallow wood or "stringy bark," South American bullet tree, South American purple heart, yellow laurel or the Hawaiian Ohia.

Contract for constructing the dock was recently awarded by the Navy Department and construction work will soon be in progress.

The Pearl Harbor dry-dock was designed by the writer, with Jos. Michaelson as assistant and expert aide, under Rear-Admiral R. C. Hollyday, Chief of Bureau of Yards and Docks, and Mr. Geo. von L. Meyer, Secretary of the Navy.

The Construction and Preservation of Macadam and Bituminous-Macadam Roads.*

By L. W. PAGE.†

The principles involved in the proper construction of a modern broken stone road are that there shall be a suitable thickness of stone to give a rigid foundation, and that the subgrade shall be so shaped and drained that no water can accumulate at the base of the road. The wearing surface is generally constructed of smaller stones than those used for the foundation, and is usually cemented together by the screenings of the rock used in construction; or, when this is not sufficiently cementitious, earth or clay is frequently used. This type of road, when properly built of suitable rock, and properly maintained, has withstood the wearing action of horse traffic in a most satisfactory manner.

The introduction of motor traffic, however, has completely upset these conditions. The pneumatic tire wears off no fine rock dust to cement the surface of the road, but, on the contrary, when traveling at high speed, it throws the dust derived from horse traffic into the air and quickly disintegrates the surface. The exact action of the pneumatic tire on the road surface is still a matter for investigation. In tests which I have made with a motor car, as near as I could compute from the rating of the engines and the cross-sections of the car, at 60 mi. per hr., it exerted a shearing stress on the surface of the road of about 137 lbs. per driving-wheel tire. The preservation of macadam roads is undoubtedly the most important problem that at present confronts the road engineer. The effect of modern traffic upon the road is coming to be more and more severe, and the problem is gradually resolving itself into the question of how to modify the ordinary type of macadam so as to produce a more permanent roadway. It is probable that the near future will present an even more serious phase of the problem, due to the use of heavy self-propelled 'busses and vans. These will exert a much greater shearing stress upon the road surface than the lighter motor cars, and, in addition, will subject the whole road (including the foundation) to strains which it was never designed to withstand.

As the primary cause of road destruction is due to the removal of the finer products of wear, the most promising method of road preservation seems at first thought to lie in the treatment of the road surface with some material which will prevent the displacement of the rock dust in the wearing surface. Water alone is known to serve this purpose to a certain extent by developing the cementing value of the rock dust, but its action is but temporary owing to its rapid evaporation. Applications of water which contains small quantities of hygroscopic salts produce perhaps a little more permanent effect, but result in an accumulation of inert sodium chloride in the road surface, which is undesirable.

In tests with light vegetable oils which could be readily applied to the road, more permanent results were obtained than from the application of water, but the road surface was made so slippery that their use was abandoned. The same effect is produced by the application of mineral oils rich in paraffine, or oil and tar distillates, which also act to some extent as lubricants, which, while holding the dust down, tend to destroy its binding qualities, and thus aid in the disintegration of the road surface. The lighter oils and oil emulsions containing a certain amount of true binding base have proved much more satisfactory where properly applied, as have also tars of suitable consistency. Their use has been a step in the right direction, inasmuch as an actual binding medium has more lasting qualities than the simple rock-dust bond.

When employed in the surface treatment of roads, the best of such materials will prove effective for only a comparatively short time, owing to the fact that, as the road surface wears down, they are rapidly removed or their binding value becomes inert. They must therefore be considered as temporary binders which will have to be applied at more or less frequent intervals, according to local conditions. As a class, they will continue to be used in the treatment of old road surfaces, both as dust preventives and road binders. In the resurfacing of old roads and the construction of new roads, however, their use will probably never prove satisfactory or economical.

Need for a modification of the ordinary form of construction is here made apparent, and, in the light of our present knowledge, the solution of the problem would seem to lie in the use of some form of bituminous binder of sufficient strength and durability to keep the road intact as long as the wearing surface exists. Many experiments have been tried along this line with different bituminous preparations, and the most variable results have been obtained. The bitumens suitable for this work consist of refined water-gas tars, coke-oven tars, gas-house tars, residual oil products holding an asphaltic or semi-asphaltic base, oil asphalts, and native asphalts and gilsonite fluxed to the proper consistency with a suitable carrying medium.

Binding value and consistency are two of the most important features to be considered with reference to the use of bitumens in road construction, and, strange to say, these features have, in the majority of cases, been overlooked. The bitumen, as it exists in the road, should have the consistency of a semi-solid, and should have the property of hardening to the proper consistency, after being applied to the road. Most of the failures that have resulted from experimental work can be attributed to the use of fluid bitumens which after application remain in a fluid condition in the road, allowing the upper course of stones to creep and deform under traffic, producing a soft, sticky surface condition in warm weather by continually sweating and oozing upward.

There are two general methods of constructing bituminous macadam roads, each of which offers certain ad-

*Abstract of a paper read before the Western Society of Engineers, Chicago, on Nov. 3. It will be printed in full in the "Journal" of the Society.

†Director of the Office of Public Roads, U. S. Department of Agriculture, Washington, D. C.

vantages. They are (1) the penetration method and (2) the mixing method. As commonly employed, no attempt is made to bond more than the upper two or three inches of stone with the bituminous material, as this has in most cases been found sufficient. Preference should undoubtedly be given to the mixing method, but its cost is usually somewhat greater, and for this reason it has not been generally adopted.

The penetration method consists in pouring hot bitumen upon the upper course of stone which has been well rolled and partially filled with clean stone chips not smaller than ½-in. diameter. The lower course should be firmly consolidated and its voids well filled with fine material before the upper course is laid, in order to prevent the hot bitumen from running through to the road bed. Application is made of approximately 1½ gals. per sq. yd., since the object is to use enough to thoroughly coat the upper course of stone. The surface is then painted with hot bitumen at the rate of not over ½-gal. per sq. yd., and clean sand, or stone chips free from dust spread on in sufficient quantity to fill the surface voids and take up all excess of bitumen, after which the road is consolidated and made smooth by rolling. After this it is advisable to close the road to traffic for a day or two in order to allow it to set.

The principal disadvantages of this method are as follows: (1) It is almost impossible to obtain an absolutely uniform distribution of the bitumen; this results in the accumulation of the binder in pockets which are apt to produce soft spots, and in some portions of the road the individual stones are not sufficiently well covered to produce a satisfactory bond. (2) It is necessary to use more bitumen than is actually required to coat the road stone and bond them together. (3) It is difficult and sometimes impossible to employ a bitumen of sufficient original consistency to produce a satisfactory bond, owing to the fact that such bitumens congeal too rapidly, when applied to cold stone, to insure a proper penetration. The bitumen must, therefore, have the property of acquiring the right consistency after application.

On the other hand, this method has the advantage of being easily and rapidly carried out. No costly apparatus is required, and the labor item is comparatively low.

In the mixing method, a roughly graded broken stone aggregate is first coated with hot bitumen and then spread to a depth of two or three inches upon the foundation course. After being thoroughly rolled, this course is painted with hot bitumen and covered with sand or stone chips as under the penetration method. The process of mixing may be conducted either by hand or by mechanical mixers, and with either cold or hot stones, preferably the latter.

Instead of separating the crushed stone into various sizes and then mixing the different sizes in given proportions, it is often possible to utilize the crusher run of material from 2-in. size down to dust, thereby considerably reducing expenses. Other things being equal, that mineral aggregate having the lowest percentage of voids after being applied and rolled should produce the best results. About 6% of bitumen should be employed in the mixture, and this will usually prove to be less than that required in the penetration method.

The disadvantages of the mixing method as compared to the other two are as follows: (1) The cost is as a rule somewhat greater; (2) with the same labor force, work cannot proceed as rapidly; (3) to obtain the most economical results, more elaborate apparatus is required.

It has the advantage, however, of producing an absolutely uniform road in which the bitumen is evenly distributed throughout the upper course and covers each individual fragment of stone. Work can be successfully carried on during colder weather than is allowable for the penetration method. If hot stone is employed, a bitumen can be employed of such original consistency as will be required in the finished road to satisfactorily meet local conditions.

Where suitable binders have been employed, satisfactory roads have been constructed according to both methods. In these roads the mineral aggregate is so firmly bonded that the surface is capable of successfully withstanding the strains imposed by automobile traffic, and, at the same time, the wear from horse-drawn vehicles is greatly reduced owing to the increased resiliency of the road.

As traffic conditions become more severe, it is probable that a further development of the bituminous macadam will take place relative to the construction of the foundation course. A cement grouted foundation may be substituted for the stone foundation, and this may be superseded by a concrete foundation. Indications point toward an evolution of the broken stone road toward what may be more properly called a pavement, where the limiting factors are the cost and the character of the traffic to which the road is subjected.

Discussion.

Mr. A. N. Johnson, M. Am. Soc. C. E., State Highway Engineer of Illinois, remarked that we have got away from the inherent principles of macadam construction, and may have to work back to them. The main strength of that construction is in the mechanical interlocking of the stones that form the road. In a bituminous mixture, prepared ready for laying, there will be large and small pieces not wedged together, as part of the void is filled with the semi-plastic binder. Thus the road is not as strong as when built on the macadam system proper. When the semi-plastic binder is poured over a road already built, the sticky mud causes the wagon wheels to pull out the binder and thus expose the stones to the action of the traffic so that they will be loosened easily. If a binder must be used, it should be in such a way that it will not reduce the strength of the road.

That the motor car traffic will be so heavy as to necessitate abandoning the macadam system seems to be a very distant condition as far as the ordinary country road is concerned. But if it is abandoned, the new paving will probably be in the way of brick or concrete construction, rather than in the use of a plastic binder for broken stone. Where the traffic is distributed over the road the bituminous paving may show good results, but when the traffic is concentrated in one line, as on country roads, the squeezing and rolling action can be prevented only by the inherent stability of a construction that will allow no movement of the individual particles.

Mr. Page agreed with Mr. Johnson that we are getting too far away from the real principles of macadam construction, and stated that in the last few years people have gone wild over the bituminous binder, for which all kinds of impossible claims have been made. But a stone road carrying heavy automobile traffic needs a stronger binder than the natural cementing value of the rock dust. In this connection he referred to Mr. Johnson's advocacy of the plan of putting the smaller stones at the bottom and the larger ones on top, which is the reverse of the real macadam construction. This, however, is used mainly with stone of inferior quality. There are two reasons for using granite for the upper course of a limestone road: (1) it is harder, and when a bituminous binder is used it makes a more enduring construction; (2) the mixture of the limestone with a highly silicious rock, like granite, greatly increases the cementing value and gives a stronger bond.

Mr. Chamberlain remarked that the macadam construction is satisfactory for the foundation, but that the top surface must be so made and cemented that it will not be worn or disintegrated rapidly by the traffic. For ordinary traffic, the binder of stone, screenings or gravel has been sufficient to cement the surface and to give a good drainage surface. With automobile traffic, however, this class of binder is not efficient. He proposed a top coat of 2-in. stone, followed by a binder of a hot tar or bituminous composition; on this would be spread a layer of ¼-in to ⅜-in. chips (without dust), with a light coating of tar and a final surfacing of ¼-in. screenings, well rolled.

The specifications of the city of Chicago call for 3-in. granite on the limestone base, with a binding of gravel and a top dressing of granite screenings. But with the Wisconsin granite it is very difficult to bond this stone with a gravel binder. Where limestone has good cementing property, it will be found that there are clay seams in the rock, and that this clay is ground up with the stone in the crusher so as to form a natural binder. Where there are no such clay seams, the limestone will not cement or bond.

Mr. Linn White, Chief Engineer of the South Park Commission, pointed out that if too much fine stone is used the road cannot be strong, as instead of merely filling the voids, it will keep the larger stones apart so that they cannot interlock into a solid mass. As to the granite surfacing, he finds that where this is used it is necessary to use also some sort of cementing material such as clay or gravel. On roads where this was not used, the granite never did become bonded to the main course of limestone, and the surface lasted only a few months. The point now is to find some method of holding the surface stones together, whether they are of limestone or granite. He has had good results with a bituminous binder, mixed before laying, but existing roads can be improved by the [illegible]ing method of applying the binder. The two systems are distinct, the first is bituminous concrete and the second is macadam construction. Mr. J[illegible]son thought the poor results with granite top dressing on the Chicago boulevards was due to the fact that automobiles form 75% of the traffic and their rubber-tired wheels have not the necessary crushing and grinding action to reduce the chips to dust and work them into the paving. On country roads, the experience has been the reverse. Some limestone screenings have no cementing property, and the coarser limestone of the body of the road is covered with granite, with excellent results.

Mr. Page differed from Mr. Chamberlain as to the bituminous surfacing, and preferred to put a dressing of ½-in. chips before applying the binder, in order to prevent the latter from working too far down and forming large pockets. It is not necessary for the material to penetrate more then 3 ins. As to the effect of the rounded form of rubber tires, he did not think this of much importance, and his experiments have included both round and flat tires. He did not believe in the use of clean gravel as a binder; when an inert substance is necessary clay or loam are better and cheaper, but these may exist in the gravel.

A Tarless Oil-Gas Producer.*

By A. B. DAVIS.†

The author's attention was first called to the Darling producer during the latter part of January of the present year, at the convention of the Indiana Gas Association in Indianapolis. There he met a member of the manufacturing company who asked him to make a trip to Lima, Ohio, where an experimental plant is set up, and to investigate the apparatus to his own satisfaction as well as for the purpose of satisfying others that certain claims made for it were justifiable. In the latter part of February the author made a three days' stay at the plant and made a series of tests on the apparatus. Before going into the tests of the results it will be necessary to understand the construction of the producer:

Fig. 1 is a sectional drawing of one of the nozzles. Oil is fed through the upper needle valve and air through the lower one. Both air and oil are under

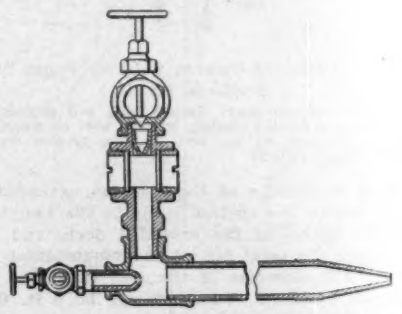

Fig. 1. Oil and Air Nozzle. Darling Oil-Gas Producer System.

equal pressure. The hole through which the mixture passes is 3/16-in. diameter and the air hole ⅛-in. A sight-feed glass is provided so as to regulate the flow of oil.

Fig. 2 shows the burner with nozzle attached. It is an iron casting, cored so as to form eight compartments running the full length of the burner. These compartments are arranged so that the mixture enters the bottom center one (1, Fig. 3), passes the length of the burner and enters 2, traveling back to the front end, entering the two compartments marked 3, flowing back and down into 4, forward and into 5, whence it passes out through a series of holes shown in Figs. 2 and 3. Here it is ignited, being supplied with the necessary air from the openings in the firebox. The holes at the sides of the burner are arranged so as to direct the gases downward for the purpose of keeping the burner hot. The two upper rows of holes direct the gas upward against and between the retorts, which are placed two or three inches apart in the frame.

Fig. 4 is a photograph of one of the retorts with the nozzle in place. The interior construction is very similar to that of the burner itself. After the mixture passes through the various channels of one lower retort it is passed through similar channels in an upper one (Fig. 5).

*Presented at the meeting of the Ohio Society of Mechanical and Electrical Steam Engineers, Lima, Ohio, Nov. 19-20.

†Chemist, Indianapolis Gas Co., Indianapolis, Ind.

Fig. 1 shows the front of a 32-retort outfit. The burner is situated below in a firebox, and the retorts are arranged above in pairs, one over the other.

Both the burner and the retorts are fed with a mixture of air and oil, the burner being kept hot by reflex heat, and the gas formed is burned under the retorts in turn to keep them hot. The gas made in the retorts is taken off at a manifold at the top of the setting, purified and stored in a holder ready for use in any kind of gas appliance. The remarkable thing about the producer in question is that it can be operated without the production of tar, while all other processes known to the author, producing gas by the decomposition of oil at a high temperature, also produce more or less tar, some processes

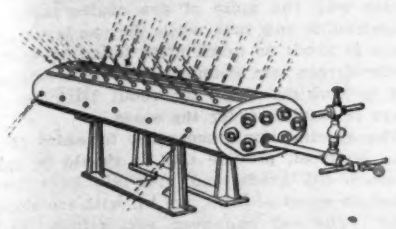

Fig. 2. Burner For Heating Retort. Darling Oil-Gas System.

converting into tar as high as 25% of the total volume of oil fed to the retorts. Carburetted water-gas machines convert into tar on an average about 20% of the oil used in carburetting the gas. Several processes on the market, similar to the one under consideration, "crack up" the oil in a hot retort in the presence of steam and produce large amounts of tar.

The question arises: Why is it possible to "crack up" the oil in the presence of air at a high temperature without producing tar, while, if steam or inert gases be used, tar is produced? We well know that oil alone in the retort will produce tar, just as in the Pintsch process used to make gas for railway cars. This gas may be easily made with the apparatus described by shutting off the flow of air into the retorts, and then, as in the Pintsch process, about 20% of the oil is converted into tar. After careful study of the conditions, it has been possible for the author to arrive at only theoretical conclusions, which, however, seem to explain the results obtained. The composition of crude or gas oil may be represented by the formula

$$C_n H_{2n+2}$$

or graphically;

$$H-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-C_n H_{2n+1}$$

The oil when heated to a high temperature shows a tendency to "crack up" into hydro-carbons of lower molecular weight, at the same time producing compounds of the olefine type from the paraffines by causing the

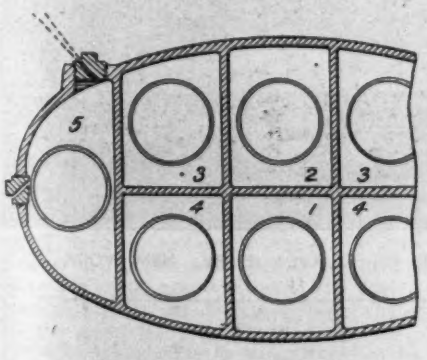

Fig. 3. Section of Burner.

oil to drop two hydrogen atoms at one or several points in the chain. These olefine compounds may be represented by the formula

$$C_n H_{2n}$$

or graphically:

$$C H_2 C H - C_n H_{2n+1} \text{ or}$$
$$C H_2 = C H - C H_2 - C H_2 - C_n H_{2n+1}$$

The formation of paraffine oil tar depends on the polymerization of these high olefines which always takes place when they are heated to a high temperature. The tar may be represented by the following general graphic formula:

$$(C_n H_{2n+1} - C H = C H_2)_X$$

We may consider it a mixture of many compounds—some of which are of very high molecular weights, which have resulted from the combination of the olefines—and the compounds forming the tar may be considered to have one or several bensine rings in the molecule and with one or many side chains on each ring, perhaps intrically connected among themselves. It has been found that the decomposition of the oil into gas takes place best at a temperature of from 1,350° F. to 1,470° F. In the presence of oxygen we may theoretically express the reactions which take place as follows: An extension of the first graphic chain formula gives

$$H-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-C_n H_{2n+1}$$

This splits up according to the following separation,

$$H-\overset{H}{\underset{H}{C}}=\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}=\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}=\overset{H}{\underset{H}{C}}-C_n H_{2n+1} \quad + \quad H-O-H \quad + \quad H$$

in which the oxygen causes the paraffine chain to loose two atoms of hydrogen at several points in the chain, causing double linkages that are always weak spots in the chain, which is then broken up by heat into largely ethylene, acetylene and hydrogen. The presence of oxygen in the retort seems to cause the olefines formed to break down at once into permanent gases without allowing them to polymerize to tar. As proof that such a reaction takes place we find, if we look at the analysis of the gas, that it contains 25 to 30% of gases soluble in bromine water, these being largely ethylene and acetylene. We find further that the gas contains very little carbon dioxide and carbon monoxide, showing that the oxygen of the air had combined with the hydrogen of the oil to form water, rather than combining with the carbon to form either carbon dioxide or carbon monoxide.

In order to settle more definitely to the author's satisfaction whether or not the conclusions, that the oxygen from the air used, prevented the olefines from the oil from polymerizing, the problem was presented to Dr. J. Bishop Tingle at a chance meeting with the author during a meeting of the American Chemical Society in Detroit this summer, who, after some study, expressed the opinion that the above conclusion in this matter is probably correct. The problem was also placed before Dr. Wm. A. Noyes of the Bureau of Standards, who answered the author's letter as follows:

The explanation which you give for the lack of tar in your process is probably partly correct. I think also that, in the original decomposition by heating, the free valences of the carbon, which under ordinary circumstances caused the polymerization, are saturated by oxygen or hydroxyl, followed by the loss of water in such a manner that the resulting hydrocarbons do not readily polymerise. Just what happens, is hard to determine and I do not, for the moment, see any very direct method of experimental study of the question. The fact is, of course, very important technically. From the scientific point of view it is possible that there are a great many different factors which unite to give the results obtained.

The importance of this letter lies not in the fact that it partly confirms the views expressed, but in the fact that Dr. Noyes apparently does not for a moment consider the production of gas from oil without the production of tar impossible.

Results of the tests made on this gas producer follow.

Kind of oil used	Lima Gas
Time of run	1 hour
Gas made, cu. ft.	1,486
Air used, cu. ft., atm. press.	583
Pressure of compressed air in lbs.	35
Volume of compressed air, cu. ft.	250
Oil entering retorts, gals.	19
Oil recovered from scrubber, gals.	8.5
Oil converted to gas, gals.	10.5
Oil entering burner, gals.	4.0
Total fuel and gas oil for run, gals.	14.5
Total oil, 1,000 cu. ft. gas made, gals.	9.76
Total oil used in retorts, per 1,000 cu. ft. gas made	7.07
Total oil used in burner, per 1,000 cu. ft. gas made	2.69
Air per 1,000 cu. ft. gas made atm. pressure	398
Air per 1,000 cu. ft. gas made compressed	167
Gross B. T. U. per cu. ft. of gas made	844.5

Chemical analysis of gas made:

	Per cent.
Carbon Dioxide ($C O_2$)	2.0
Illuminants soluble in Bromine	25.5
Heavy Hydrocarbons	0.5
Carbon Monoxide ($C O$)	1.5
Methane ($C H_4$)	35.0
Hydrogen (H_2)	5.5
Nitrogen (N)	30.0

If we theoretically consider that the oil used on this series of tests contained 18,200 B. T. U. per M. and has a weight of 7.2 lbs. per gallon, we obtain the following efficiency:

Heat units of oil used in retorts and converted into gas, viz.:

18,200 B. T. U. × 7.2 lbs. of oil per gallon × 10.5 gals. used in retorts = 1,375,920 B. T. U.

Heat units in gas made.

1,486 cu. ft. gas made containing 844.5 B. T. U. per cu. ft., viz.:

1,486 cu. ft. × 844.5 B. T. U. = 1,254,927 B. T. U., which is equal to 91% recovery in heat units.

[It should be noted that no account is here taken of the oil consumed by the burner. Considering this, the efficiency is reduced as follows:

18,200 × 7.2 × 14.5 = 1,905,000 = Total B. T. U. in oil used.

Recovered B. T. U. in gas; 1,254,927.

$$\text{Efficiency} = \frac{1,254,927}{1,905,000} = 0.66.$$—Ed.]

For a practical test one may refer to the report of Mr. H. W. Hess, Chemist of the Libbey Glass Works.

THE LIBBEY GLASS CO., CHEMIST'S REPORT.—

The Smokeless Heat & Power Co.,
Cleveland, Ohio.

Gentlemen: Below you will find briefly summarized the results of a run made by your gas producer at this plant, the gas being used in a glory hole.

Gas made—

First day	33,733
Second day	29,197
Third day	28,960
Fourth day	25,630
Total	117,520

Amount of Oil Used—

Gallons oil used in retorts	687.33
Gallons oil used as fuel to gasify the above 687.33	241.31
Total	928.64

Gallons oil used to produce 117,520 cu. ft. of gas.

The above gas ran about 750 B. T. U. and 15 candle-power.

Cost of Gas (117,520 cu. ft.)—

928.64 gals. oil at 2½ cts.	$23.21
100,000 cu. ft. air	1.00
Labor (based upon one man running four sets)	4.00
Total	$28.21

1,000 cu. ft. cost 24 cts.

Comparative Cost of Running Glory Hole for 24 Hours.—

Using your special burner for oil direct, oil, at 2½ cts.	$3.16
Using your gas from holder	7.05
Using natural gas at 31 cts. per 1,000.	10.65

Yours very truly,
The Libbey Glass Co.,
Henry W. Hess, Chemist.

All of the above tests show only results obtained while working to produce a gas for power purposes. In April of this year the author spent a week at an experimental plant in Cleveland to develop the gas for lighting purposes as well as power. After many experiments we found that by using the proper Bray burners we could obtain a light far more powerful than that given by either coal or carburetted water-gas and reaching as high as 50 c.p., with the gas burning at the rate of 5 ft. per hr., results calculated to 60° F. and 760 mm. We found also that we could obtain any desired candle-power gas, merely by varying the proportion of the air to the amount of oil fed into the retorts within a range of from no candle-power at all up to 50. When a very low grade

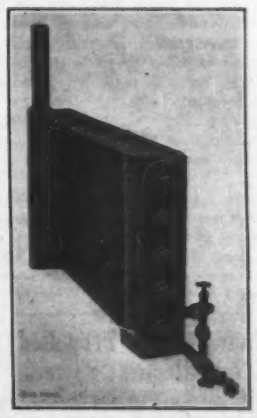

Fig. 4. Retort of Darling Oil-Gas Producer.

of gas was produced, or even gas up to 600 or 700 B. T. U. per cu. ft., no tar was produced; but with the very high candle-power gas, considerable tar was obtained, as we were making virtually Pintsch gas.

The question is often asked as to how the gas works in the numerous appliances on the market. On all gas engines it works perfectly, and in all types of gas lights made for water or coal-gas there is no difficulty in adjusting the lights so that the producer gas gives most excellent results, in many cases the light from the producer gas being far more brilliant than with coal or water-gas. This is especially true of lamps with Welsbach mantles. There has been some little trouble with gas stoves owing to the fact that the specific gravity of the producer gas is just about the same as air; in some cases slightly higher. The specific gravity of coal gas is only about 0.48, and carburetted water-gas 0.65, natural gas 0.55—0.6, so that practically all the stoves on the

market are made to use a gas which is about one-half as heavy as the oil gas made by this producer. Now, according to Bunsen's law, the rates of flow of two gases through an orifice are to each other as the square root of their gravity. Therefore, since our gas is twice as heavy, it will flow as 1 to 1.414, when compared with gas at a gravity of 0.5. For this reason and because of the large quantity of nitrogen present from the air, only the oxygen of which has been used, the small and numerous orifices in a gas stove burner are not as a rule large enough to admit the oil gas flowing through rapidly enough and have to be drilled out about 50% larger. Unless this is done, the flame of a rose burner has a marked tendency to blow itself out, as any gas will do, when fed to a burner under too high pressure. This difficulty is most easily overcome by ordering burners directly from the factory, these being drilled for the producer gas. In all other appliances on which the producer gas has been tried, it either works well without change of adjustment, or else the appliance can be adjusted without change in construction.

From an engineering standpoint, no doubt, many improvements can be made in the design of the setting of the apparatus as it stands at present. This is usually the case with any apparatus when first gotten out. For instance, a steam boiler might well be placed on top of the setting and the waste heat from the retorts would, no doubt, furnish more than enough power to compress the air used. Furthermore, preheating the air by waste heat, and proper asbestos or mineral wool lining in the setting, would all make it much more economical to operate than at present.

Since the gas is made entirely from oil it need not be purified any further than a mere tar extraction, provided the sulphur contents of the oil are as low as 1/10 of 1%.

The possibilities of the producer are almost unlimited as it generates power cheaper than can possibly be done by steam, and the gas gave good results in every field in which it has been tried. A ten-retort size, producing 1,700 cu. ft. of gas per hr. has a floor area 4 × 5 ft. and a height of 7 ft.

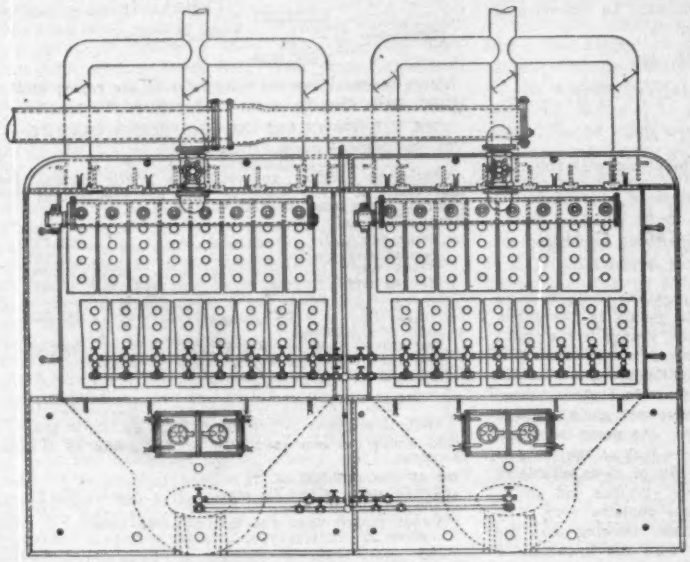

FIG. 5. FRONT ELEVATION OF A 32-RETORT TARLESS OIL-GAS PRODUCER, CAPACITY, 5,500 CU. FT. PER HR.

A Street-Railway Car Propelled by Gasoline-Electric Power.

The use of gasoline-motor cars on sparsely settled sections of steam railway lines has often been noted in Engineering News, but their use on city street railways has remained a novelty. The Receiver of the Third Avenue R. R. Co. of New York City is now trying out a type of motor car, which it is expected will replace the antiquated horse-car still seen on a few lines about New York. This type is shown in the accompanying figures. The car was built by the General Electric Co., and has been put into service on the 125th Street line, which is 2.1 miles long. Some 20 stops are made on each trip, each direction. The running time is about 30 minutes for a round trip, and cars are operated at about 2.5-minute headway. This trial car is being run some 15 hours per day here.

The car is a small single-truck design, only 28 ft. long, over all, and 19 ft. long, over the body end-frames. It is 8 ft. wide and 12 ft. high from rail to roof top. The longitudinal seats have room for 28 passengers, and the total weight of car complete, but empty, is 12 tons. The lines are rather unique owing to the appearance of the roof. Monitor windows are replaced by eight ventilating hoods. The cooling-water radiators are also carried on the roof, as shown in Fig. 1. Two exhaust pipes pass up one end to the roof and discharge upward into the atmosphere.

The truck carries all the power apparatus—gasoline engine, electric generator and driving motors. This truck has a 7-ft. 6-in. wheelbase and was designed and built by the American Locomotive Co., of Schenectady. The side frames are steel plates and the axle loads are transmitted through the usual coiled springs, hidden behind the side plates, and by semi-elliptic springs at the ends, as shown in Fig. 1.

The engine is a 21-HP., four-cylinder, four-stroke cycle type, fully enclosed and direct connected to a 15-KW. generator and to an exciter. The generator supplies the driving motor and the exciter furnishes current to the generator fields and for lighting the car. The engine has an automatic centrifugal throttling governor and runs always at constant speed (800 r. p. m.). The operator has no means for controlling the engine other than for stopping and starting. A low-voltage magneto operates the ignition system, which includes contact-magnet, spark plugs. The engine is started with a crank.

The current, at 250 volts normally, for the two driving motors is regulated by a drum controller of the same general design as those in use on small street cars. The motors are grouped first in series and then in parallel; there is additional control by varying the voltage of the generators.

It is intended in cold weather to heat the car with the cooling water from the engine jackets. For this purpose, heater pipes are installed under the seats. It is claimed that when the car is under way the noise of the engine is not distinguishable and that when the car is stationary there is about as much noise heard as when the motor-driven air compressor of an interurban car is working. Fuel for about 150 miles operation is carried under the seats.

The specifications, according to which the car was designed, provide that it should be able to climb a 5% grade and maintain on a level a schedule speed of 8 mi. per hr. with ten stops per mile. The car has been successfully tried on a 1,000 ft., 8% grade on the Amsterdam Ave. line, New York City.

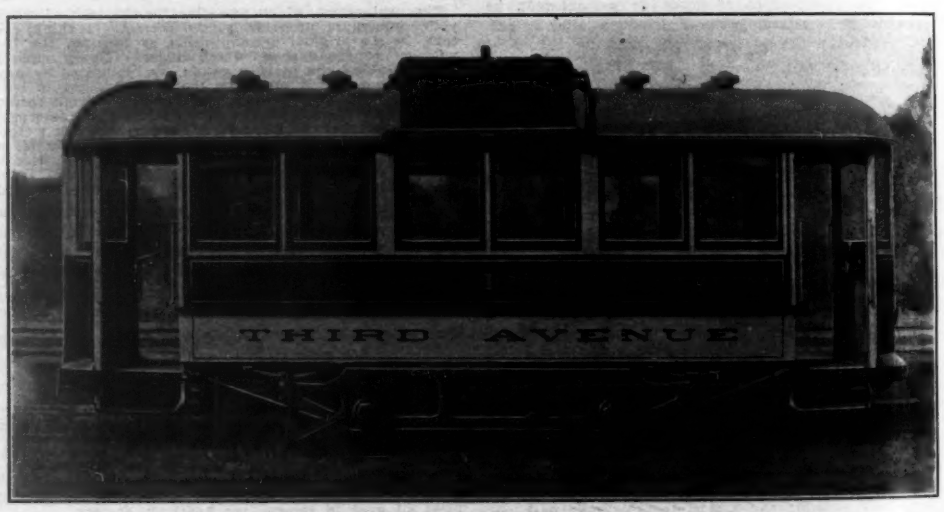

FIG. 1. GASOLINE MOTOR-CAR BUILT FOR THE THIRD AVENUE RY., NEW YORK CITY.

FIG. 2. THE 21-HP. GENERATOR SET OF THE THIRD AVENUE RY. URBAN MOTOR CAR.

A DEPARTMENT OF "AEROGATION" is to be established at the Carnegie Technical Schools at Pittsburg, Pa. It will be devoted to the study of aeronautics and experiments will be made with a view toward the improvement of existing models. Press reports state that working models of aeroplanes will be constructed in the school shops and tested above the open stretches of Schenley Park.

THE FREIGHT-CAR SURPLUS has been increasing slightly in the last month, having reached its minimum on Oct. 27 (30,896 cars). The surplus is reported on Nov. 24 as 39,528 cars, about half of this being box cars. Shortages totaling 27,500 cars were reported on the same date, as against nearly 37,000 on Oct. 27. The situation may now be expected to progress with increasing surplus of cars until midwinter.

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The advantages of crude petroleum in place of gasoline as a fuel for internal combustion engines are well known. These advantages are, first, the great saving in the cost of fuel, and second, the advantage in safety. A great deal has been done, particularly in Europe, in the construction of engines which use oils of various quality. All such engines, however, have been on the whole less satisfactory than the gasoline engine, since they require a greater amount of attention, are not as readily started, and are more expensive in construction. The Diesel motor is a notable achievement of inventive work in this field; but, while it has attained the highest economy of any type of heat engine, it involves such expense in construction and maintenance that it has never come into extended use in the United States.

To many inventors the idea has suggested itself of converting crude oil to gas, and using the gas in an internal-combustion engine; but the great difficulty with any such scheme has been the great amount of tar which is produced in the ordinary methods of making gas from oil. Recently, however, several inventors in different parts of the country have hit upon a method of converting crude petroleum into gas which appears to produce practically no tar. The oil is entirely converted into gas, and the heat absorbed in the process is surprisingly small, so that the efficiency of the process, at least according to the claims made for it, works out at a high figure.

While we have been for some time aware of the work of inventors in this field, no one of them has been ready to present his work to the public until very recently. Elsewhere in this issue we reprint a paper just read before the Ohio Engineering Society, describing one of these new oil gas producers. It will be seen from the description that the producer is exceedingly compact, compared with the ordinary gas producer which uses coal fuel. It is stated that an oil-gas producer occupying about 28 sq. ft. of floor space and 7 ft. high, can produce 1,700 cu. ft. per hour of gas having the surprisingly high thermal value of 800 B. T. U. per cu. ft. Using the figures given in the paper, it appears that such a producer would consume about 16½ gallons per hour of crude oil, worth, say, 2½ cents a gallon. Making reasonable assumptions for the available heat energy in the gas and the thermal efficiency of the engine, it would appear that the producer would be sufficient to supply an engine of about 100 brake-HP. A fuel consumption is indicated somewhat higher than that of a good gasoline engine, but as the cost of the fuel per gallon is less than a quarter of the cost of a good grade of gasoline, high fuel efficiency is not of great importance.

There would seem to be a large field for gas producers of this general type, in connection with internal-combustion engines. In marine service, particularly, the advantage of dispensing with the risk of gasoline on shipboard can hardly be overestimated. Further, while the cost of gasoline for engines of 20 to 25 HP. or less is not a serious matter, when one comes to the larger sizes of internal-combustion engines the cost of gasoline becomes a large item in the daily expense account. On the other hand, the suggested combination of oil-gas producer and gas engine may prove a formidable competitor of the suction gas producers using coal which have lately become so popular for small stationary power. Certainly, engineers who are interested in gas-engine development will watch with interest the progress of this new invention.

We understand that some contractors in the central West have been asked to pay a royalty for the use of concrete mixed wet, on the strength of a patent issued Nov. 2, 1909, to Alexander D. Ney, of Aurora, Ill. We have obtained a copy of Mr. Ney's patent, which is numbered 939,072, and it is truly one of the most astonishing documents of which the U. S. Patent Office was ever guilty.

Mr. Ney entitles his invention "Rock-like Substance," and sets forth in his specification that he has a radically different method of making concrete from that hitherto followed; "in that an abundance of water is employed in order not only to permit gravity to bring the mass to a solid, compact condition, and thereby dispense with the ramming operation, but also to provide sufficient water for the purposes of crystallization."

Mr. Ney's application was filed on July 10 last, and in his petition he swore that he believed himself to be the first inventor of the substance for which he applied for a patent. One wonders where Mr. Ney has lived for 20 years past to be so unfamiliar with the practice of the engineering world. If he will refer to copies of Engineering News published eight or nine years ago, he will find extended discussion of the comparative merits of wet and dry concrete. It was at about that time that the time-honored specifications for dry concrete were generally changed to permit or require concrete to be mixed wet. However, even at that time mixing concrete wet was far from being a new idea. As far back as the first use of concrete, it was very often mixed wet instead of dry.

It is not particularly surprising that Mr. Ney's specification should describe the making of wet concrete as a new invention, because the Patent Office is very liberal in permitting an inventor to make statements in his specifications. The office is, however, commendably strict, ordinarily, in its inspection of an inventor's claims, and usually holds down an inventor to what is strictly novel—so far, at least, as the Patent Office records extend. In the present case, however, the Office has allowed the applicant some astonishingly broad claims. The first of these claims reads as follows:

> I claim as my invention, a rock-like substance, composed, in part, of particles of earthy material,* and having the seams intermediate such particles filled with crystallized cement, the mass having therein cells or cavities formed by the withdrawal of water by crystallization, substantially as described.

We need hardly say to our readers that this claim covers all concrete, whether mixed wet or dry, as there is practically no concrete which is without the cells or cavities which the specification learnedly describes.

Mr. Ney declares in his specification that the product which he patents differs from certain prior products "by reason of the presence of such cells or cavities, which would be lacking if the mass were subjected to a pressure tending to expel the water prior to crystallization."

If Mr. Ney can show engineers how to produce concrete without such cells or cavities, by pressure or any other practicable means, he might then have an invention worth talking about.

The unfortunate thing, of course, is that the issuance of this patent gives on its face the sole right to the inventor to use the material covered by the claim which we have quoted above; and if the claim were valid, he could hold up the engineering world for the payment of such royalties on every cubic yard of concrete laid as he might please to exact. Of course such a supposition is absurd. The specification does not state the inventor's age, but the chances are that the concrete which he describes was in use before he was born! Under these circumstances, of course, his patent is invalid by anticipation.

The question may be raised, how is it possible for the Patent Office to be so ignorant of the state of an art as to allow such claims to go to issue? There are two explanations for this. The first is that the Patent Office Examiners, in their searches, generally confine themselves to the files of issued patents. There are many features of industrial practice which come into common use without ever being regarded as an invention or patented. The second and more important reason is that the Patent Office Examiners are paid niggardly salaries, wholly inadequate to secure the high grade of technically trained men who should be in charge of such important and responsible work. The surprising thing is not that an occasional bad slip like this occurs in the work of the Patent Office, but that its work is, on the whole, generally of such a high grade.

The complaint of an engineer on another page of this issue, that there is no uniformity in the results of cement tests made in different laboratories, is not an isolated case, although most of the adverse critics can hardly advance as good proofs as our contributor. Moreover, the engineer, the user of the cement, is not alone in this criticism. At the last annual meeting of the National Association of Cement Users, Mr. W. Purves Taylor, of Philadelphia, one of the leading cement testers in this country, said:

> Cement testing is a difficult process requiring experience, care, precision, and knowledge, and hence should only be entrusted to well qualified men, but too often this important work is relegated to utterly untrained and careless operators and the results obtained by such methods are really worse than nothing, as they often are positively misleading. Many tests made at the present time by supposedly responsible parties are ridiculous in their inaccuracy, as any one having knowledge of this subject will admit. Instances might be cited without number. In one case a cement was rejected as being quick setting, but an investigation showed that the test had been made in a hot room in a temperature of over 90° F. and the specimen besides placed directly over a radiator—the cement itself was entirely normal. Strength tests are often made by inexperienced boys committing every possible error of manipulation. In one case a cement reported as breaking at 125 lbs. was found to give a strength of over 250 lbs. when accurately tested. Cases of unjust rejection on the accelerated test for soundness through improper manipulation and interpretation of the results are by no means uncommon. Of the sieves used for testing fineness, not one in four has been properly standardized. These inaccuracies, it must be remembered, are not only found in the small laboratories but only too often in those of some reputation, and the cause may be found to be entirely due to the desire to cheapen the cost.
>
> It should be recognized at once that if cement tests are made it is worth while to make them well, even at possibly a somewhat increased expense.

Here is a state of affairs that demands remedy. Obviously, if the acceptance or rejection of a cement depends upon the laboratory in which the test is made, the method of testing is in need of revision. Whether this variation is due to improper observance of the specifications now almost universally adopted or to inherent error in those specifications is the question. The present specifications are the joint product of committees and societies composed of men most intimately acquainted with the difficulties of cement testing, but, nevertheless, as they are now written, the utmost care in manipulation and standardization in apparatus is necessary to ensure uni-

*"Earthy material" is defined elsewhere in the specifications as "stones, pieces of rock, slag, pieces of brick, or similar natural or artificial mineral products."

formity. It is perfectly fair then to inquire if some other method of testing cannot be devised in which comparative results may be attained to a reasonable degree of accuracy without the strict observance of detail which at present it seems impossible to obtain.

Every little while there comes to this office a letter stating that the writer is a student in some engineering school, that he has chosen a certain subject for his graduating thesis and would be glad of any assistance the editors can render in the collection of material for the preparation of that document.

The writers of such letters may have been wrongly instructed as to the proper methods of attacking any task before them, or they may merely belong to the ranks of the perennially lazy, who always avoid doing anything themselves if they can get some one else to do it for them.

One of the most important things that a student in an engineering school should learn is *how to find out things for himself*; yet many graduates from engineering schools are lamentably helpless in this matter. The student in an engineering school to-day has at his disposal, in almost every case, libraries filled with technical books and with bound volumes of engineering journals and transactions of engineering societies, most of which has been made available for use by published indexes. Admittedly, much of the indexing work has been crude and inefficient, but it is the business of the engineer always to do the best he can with the tools he has to do with.

The proper thing for the engineering student who has a thesis to prepare, or the engineer-graduate who has a report to make upon an engineering subject, is not to go around the corner and ask advice, nor write letters asking for aid. The thing for the engineering student to do is to attack the problem himself and hunt up all the published information that he can find. When he has read and digested this, and learned what is already known upon the subject, he may then have some excuse in resorting to experts for aid in solving some knotty questions on which published data are conflicting.

We wonder if all engineers resident in New York City and vicinity appreciate what a valuable and useful source of information is at their service in the engineering reference library at the Engineering Societies' Building, 29 West 39th St. This library consists of the libraries of the three societies, the Mechanical, Mining and Electrical Engineers, combined in one. It is probably the most complete and useful engineering library in the United States, and it is constantly being improved and kept up to date by the addition of the current technical books.

It should be understood moreover that the use of this library is not confined to the members of the three societies which are its joint proprietors. Any engineer is at liberty to make use of the library; and every engineer resident in New York or vicinity ought to be familiar with this valuable source of professional information.

Several times in the past, notably in the case of the buildings for the Edison Portland Cement Co., at Stewartsville, N. J., we have had occasion to describe the construction of reinforced-concrete buildings from members molded on a casting board and erected in the structure as separate pieces. In all of these works the engineer has claimed for this method a pronounced economy over any other style of construction of equal stability, fireproofness or longevity, but these claims have not always been verified by figures. On another page of this issue, however, Mr. Mason D. Pratt presents a comparative cost-account of two buildings of identical size, local conditions and material, one with the ordinary cast-in-place reinforced concrete and the other of the separately molded type, and the figures clearly demonstrate that the latter has an advantage in cost of at least 15%.

A study of the items will show that the saving is practically all in the forms. Material cost is about the same, although a trifle more steel is used in the members to be slung into place already cast, and the labor of concreting, if the cost of erection is added in, is practically even. The cost of lumber for forms and the labor account for their construction, on the other hand, is about three times as great when the carpenters have to erect a standing structure in which to place the concrete instead of a rough framework flat on the ground. That the forms are the expensive part of concrete work is well known, but it is of interest to know just how much this extra cost is due to the fact that the framework must be put and kept in place as an independent building.

Although this separately-molded method gives economical results, it must be borne in mind that it is of limited application. In the first place the rigidity at connections is certainly less than in a monolith, so that for high buildings the method can hardly be approved. Where a number of window openings are necessary the difficulties of side wall slabs becomes at once apparent, not only in arranging the erection but also in the multiplication of forms for the various shapes. Then, too, the mortar joints on the face walls hardly add to the surface appearance, particularly as the method of erection usually requires some surface coating to reduce the irregularities at joints. Finally the placing of separate floor and roof slabs limits the spacing of columns in at least one direction or else requires an uneconomical number of floor beams. In spite of these objections, the system is admirably adopted to barns, shops or storehouses where the difficulties noted above are of little consequence.

The Problem of Flood Protection.

Flood protection, always a vital problem to inhabitants of river bottom lands and river cities, is becoming a more urgent matter every year, as values increase and population density rises. It is likely to be an active subject of public interest in the immediate future. We are near the beginning of an epoch of building flood-protection works. But we have not yet entered upon this epoch. Virtually no flood-protection work is being done to-day.

Such cities as Kansas City, Pittsburg, and Sacramento have begun wrestling with the problem. Scores of other places in equally unfavorable situation are lacking only in the necessary unity of purpose and concentration of resources to enter into preparations for protective work. The news of every Spring season demonstrates that river inundations make damaging appearance on a large number of our streams, and cause losses of very great extent in the aggregate. Large sums could be invested profitably in works to reduce this loss. Yet the places where even a bare beginning has been made in dealing with the problem are few indeed. We may say in an approximate sense that except in the lower Mississippi and Ohio valleys nothing but preliminary examinations has yet been accomplished.

It appears that there is no dearth of variety of method for controlling floods. This is said not from a consideration of the general problem, but from contemplation of the diversity of schemes proposed at the several points where flood protection has been under discussion. The diversity of ideas represented by these schemes arises in part from a natural and proper cause; for, as the requirements of two cases are apt to be radically different, the means employed to meet them can rarely be similar. Moreover, it is true that flood protection as an engineering problem is yet in a very unsettled condition, very unlike that of most other problems of engineering planning. It may well happen that two equally excellent engineers called in at different times to advise about the same case of flood exposure will recommend very different plans of procedure.

But there is another factor in the variation of opinion on flood protection, namely, that this field is by no means conceded to belong to the engineer's domain. That engineers are necessary for the detail work, for designing structures, making maps, etc., is of course recognized, but the task of planning out a general project is not considered to be specifically engineering work. So far as the technical study of hydrology, river flow, etc., has yielded definite conclusions, these are but little known and still less respected by the lay community. River improvement in general and flood protection in particular is regarded as a field in which one man's ideas are as good as another's, the layman's as good as the engineer's. In nearly every local flood-protection campaign the subject is treated as though it were primarily a matter of adjusting real-estate values rather than a matter of meeting natural conditions, and these very difficult.

Perhaps this is due to the fact that, while the subject in reality is many times more involved than most other problems of public works, it *looks* simple and within the range of every man's knowledge. Witness on this point Governor Stubbs of Kansas, as quoted in the Topeka "Capital" on the Mississippi deepening scheme:

> All his way down the Mississippi, said the Governor, he had not seen a thing that required the skill of an engineer to correct. "Any ordinary man with good horse sense can dike that river and give it a 14-ft. channel and do it in five years.

And this statement is mild in its bumptiousness compared to some assertions on the subject, made for example by men who advocate protecting a city from floods by widening the channel just above and below, and retaining the narrow, obstructed channel in the middle of the city, where land cost is high.

A discouraging phase of the matter—discouraging because it makes the prospects of realization rather remote—is that wherever a really comprehensive scheme of flood protection has been worked out, it calls for enormous expenditures. The cost is always measured in millions, usually in tens of millions. The average citizen is utterly unable to comprehend why the moderate task of fencing off the top few feet of flood in the river that runs through his city should cost such fabulous sums. Yet the facts will always explain this simply enough.

For example, a city has spread out on a convenient level flood-plain, and has in the process of growth massed itself closely about the low-water channel. In flood-time the river finds its valley practically dammed by the city, and, backed up thereby to greater heights than in prior years, it tops the levees proportioned for earlier flood levels and inundates the city. The common citizen disregards the damming effect of the obstructions he has created, and sees only that the levees were a trifle too low; and in concluding that higher levees will keep the water out of the streets he dodges the question of whether he can constrain the whole flood volume to wait its time and flow through the narrow channel. Schemes for an extensive control of floods by works reaching far up the river, perhaps with costly storage reservoirs, or demands for a wider and less obstructed channel requiring the cession of levee property and rebuilding of bridges, do not appeal to his understanding.

This condition of affairs needs to be stated and restated, in spite of being quite obvious, because the inhabitants of river cities are prone to seek and accept, in explanation of why flood damages seem to be increasing, reasons which do not reflect on their city. It is partly on this account that the theory of increasing flood heights, i. e., increasing variability of stream flow, with the attached theory of the harmful effects of deforestation, has gained such wide credence, though it is as yet unproven, and though the obstruction of rivers by city growth often gives a readier explanation.

An equally important cause for the divergence of opinion on flood protection lies in the fact that the problem seldom stands alone, but nearly always has other problems intimately associated with it. Usually the chief or only associated problem is navigation. Sometimes power production or water-supply also have an important place, while in some parts of the country the important thing is water-supply for irrigation. Wherever the question is thus composite, the solution must adapt itself to all the

elements and naturally it becomes a much more extensive and costly project than the flood-protection purpose alone would seem to account for. It is easy to understand that citizens who are ready to pay money for protecting their property from flooding might object to having the work complicated and the cost multiplied by the inclusion of navigation or power-production features. But it is also not hard to see that a flood-protection plan which disregards all consideration of navigation or the other associated problems must be condemned upon a broad view of the situation.

This matter of complication and cost appears in exceptionally interesting form in the Sacramento-San Joaquin project developed by Mr. A. D. Foote, as described on another page of this issue. He has elaborated a very large scheme for the regulation of the rivers in the Great Valley of California, covering the purposes of flood-prevention, irrigation, navigation, and agricultural reclamation. This last is the novel element, inasmuch as no previous proposal for fertilization by river silt has been made in this country, so far as we recall. Basin irrigation is a new thing on this side of the water, since aboriginal times. The scheme presented looks attractive, though its practicability is by no means proven by the author's paper.

The enormous outlay which the Foote project requires is to be specially noted. The city of Sacramento is now working to get a flood-protection scheme on foot. News reports have told how the city was to spend $75,000, how a popular vote on the appropriation was to be taken, and how the money was at last raised and paid out to acquire land. Some hundreds of thousands of dollars are expected from state and national government. The total of less than a million dollars is intended to give Sacramento and the bottom lands along the lower course of the Sacramento River protection against flooding in the future. Contrast this expenditure with the figure a hundred times as great that Mr. Foote estimates! What more easy to understand than that the cheaper plan should be adopted?

The flood problem of the Great Valley, it happens, affords a striking example of the uncertainties that reside in river problems. In 1904 an engineering commission, reporting on flood protection, stated that the maximum flow which must be taken care of is about 250,000 cu. ft. per sec. Only three years later, in spring of 1907, a phenomenal flood came down the valley with an estimated discharge of nearly 600,000 cu. ft. per sec., over twice as great as the worst possible flood foreseen by the commission. [The detail figures may be found in the Transactions of the American Society of Civil Engineers, 1908, in a paper by Messrs. W. B. Clapp, E. C. Murphy and W. F. Martin.] This startling overthrow of expert predictions is significant. It means that careful long-time records of weather conditions and river discharge must be accumulated before wholly reliable projects can be drawn up, and such records are not available on most of our rivers. Incidentally the case of the 1907 flood showed that unforeseen occurrences may interfere with the working of a flood-protection system. A system of headwater reservoirs was suggested in the very paper describing that flood. The flood, however, occurred after a period of heavy rainfall continued for two months, which soaked the ground so that the final heavy rain was almost all shed into the streams. Under these conditions, however, the reservoirs would in all probability have been full, and therefore unable to hold back any part of the concentrated rainfall that caused the flood. The reservoir system, therefore, would hardly have been a protection on the very occasion when it was most needed.

Mr. Foote's scheme merits most serious study. While highly sketchy, it is a coherent project for an undertaking of ultra-radical character, adapted to special local conditions. The physiography of the Great Valley is peculiar, and the asserted applicability of the basin flooding scheme depends on these peculiarities. These are not found elsewhere in this country, and for this reason the utilization of flood-waters by basin irrigation may not be possible in other cases (reserving a possible doubt for the Mississippi bottoms). Thus, even if the Foote project be carried out, it may never find imitation on this continent.

In spite of this its execution and its successful operation would mark an epoch in American river control. Why this should be so may be understood when we think that, with all the money and all the thought that have been devoted to river improvement, we have no single stream that is regulated in its full extent and for all conditions. On the other hand we have plenty of cases of small, localized "improvement," which, seeking to accomplish with a cent what needs a dollar, are futile from their inception to their ultimate decay, and besides serving no useful purpose act to discourage more extensive and better planned control enterprises.

LETTERS TO THE EDITOR.

Is Delay in Underpinning a Settling Building Justified?

Sir: The Criminal Courts Building in New York City has shown evidence of unstability which raises serious questions as to its future. The building is twenty years old and cost, approximately, $2,000,000. It is said that it is not adequate for the service that it must render. More room is needed. It has been recommended that nothing be done for another year to arrest the settlement which has been observed during the past two years and which has resulted in alarming cracks in the walls, some of which are out of plumb about five inches.

If the settlement continues for another year, the building is liable to disintegrate to such an extent that it will have to be torn down; and this is evidenly not looked upon with serious disfavor by those who feel that a larger building is needed any way. It is perfectly feasible to so strengthen the foundation of this building that not only will the settlement be arrested, but enough bearing power can be developed to support an additional number of stories on top of the building. This work can be done at once, without interfering in any way with the present occupancy of the building. It is not apparent in the recommendations that have been made to observe the settlement for another year or more, just what advantage, financial or otherwise, the city will obtain by the delay in strengthening the foundation.

It is purely a matter of opinion and conjecture, be that expert or otherwise, as to what will happen to this building during another year, if the settlement is not arrested, and in accepting recommendations for delay, the city is taking a financial risk that no business man or private corporation would consider except under dire necessity. The exact degree of risk is unknown and unknowable, but the amount involved is approximately $4,000,000, as shown by the following comparison of what may happen and what can be done at once to avoid so great a possible loss to the city.

WHAT MAY HAPPEN.

Tearing down building after another year, and replacing present floor space, about..	$4,000,000
Additional floor space	1,000,000
Total	$5,000,000

WHAT CAN BE DONE.

Strengthening foundation to arrest settlement and provide for additional floor space	$500,000
Additional floor space.....	1,000,000
Total	$1,500,000

POSSIBLE SAVING.

In construction cost	$3,500,000
In use of building during construction.....	300,000
Interest on capital during construction.....	500,000
Total saving	$4,300,000

I respectfully suggest that the attention of our Business Administration be brought to these facts.

Very truly yours,
Philip B. Windsor,
M. Am. Soc. C. E.

1 Madison Ave., New York City, Nov. 19, 1909.

[This criticism was submitted to the members of the Board of Survey which reported on the condition of the Criminal Courts building to the Mayor. Their reply is given below.—Ed.]

Sir: Mr. Windsor, in his letter to you of Nov. 19, 1909, argues that in deciding not to strengthen the foundations of the Criminal Courts Building at once the City of New York "is taking a financial risk that no business man or private corporation would consider except under dire necessity."

He does not appear to be completely informed as to the report made by the Board of Survey appointed by the Bureau of Buildings to examine the building and to determine upon its immediate treatment. This report indicates clearly that the three engineers who comprised that Board realized that the future behavior of the building was an uncertain one and that it might develop a very serious situation. With this in view they recommended an immediate and complete system of observation with records, and further, that if these observations indicated movements of grave significance, there should be then determined a method of treating the whole question. The Board of Survey did not recommend that nothing should be done for one year, but they deemed it necessary to require that the observations should be prolonged for one year, even if the movements were not serious.

The Board of Survey is necessarily a temporary body and has no prolonged responsibility, and they therefore provided for proper professional inspection and observation; also that any radical measures which might be required should be adopted whenever necessary, either in one month or six months, or a year. This is very different from Mr. Windsor's understanding that nothing was to be done for one year in any event.

The Board of Survey did not take into consideration the method by which future difficulties should be overcome, as this was not within the scope of its duties. It did determine upon the immediate steps necessary, and these have been taken out.

Respectfully,
Owen Brainard,
James P. Whiskeman,
Dec. 4, 1909. Nelson P. Lewis.

High Vertical Compressions in I-Beams Tested Under Concentrated Load.

Sir: In your issue of Aug. 12, 1909, you published the results of some tests on I-beams and made editorial comment thereon. The result of these tests should not be taken to represent the action of such beams under the loadings of practice, which are generally uniform or nearly approaching it. The effect of a large concentrated load on such a beam may produce a stress of maximum intensity in a direction nearly vertical. Take for example an I-beam loaded as shown in Fig. 1. The forces on a short piece of the beam located between the dotted lines, which are taken just to the left and right of the load, are as indicated in Fig. 2. The forces V_L and V_R whose sum equals P, are the total shearing forces on the sides, and are developed throughout the entire depth of the cross-section, being a maximum at the neutral surface and zero at the top and bottom of the beam. From the well-known distribution of shear in flexure on such a cross-section we know that there is a very large normal stress on a horizontal plane at the junction of the web and flange. Fig. 3 will, therefore, represent the vertical forces on the top flange for the short piece taken. It is also clear that part V_L + part V_R + $N = P$. Part V_L and part V_R may be readily determined for any special case, but we know they are small, as most of the shear is carried by the web, so that $N = P$ nearly. If the load P is applied in a short length, N may produce a unit-stress greater than the unit-stress on a vertical plane. Hence on an elementary cube just below the top flange and very near the center of the beam we would have the forces

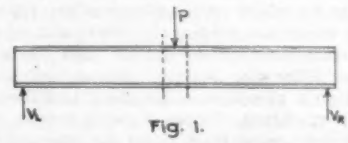


Fig. 1.

Fig. 2.

Fig. 3.

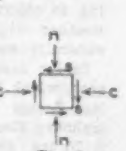


Fig. 4.

n = vertical unit-stress on the horizontal plane due to N.
c = horizontal unit-stress on the vertical plane due to flexure.
s = vertical and horizontal shearing unit-stress.

These forces may be combined by well-known methods and the direction and intensity of the resultant determined. If n be much larger than c, as it may well be, the line of maximum stress intensity will be almost vertical. For such a case an extensometer attached to the top flange in a longitudinal direction would not give a measure of the maximum stress in the beam. The recorded manner of failure of the beams tested indicates high vertical web stresses. In further support of my contention that the result of these flexural tests should not be considered as representative of practice, attention may be called to the fact that webs are always stiffened under concentrated loads of large amount.

This communication applies only to the flexural tests.

Yours truly, C. W. Hudson.

45 Broadway, New York City, Oct. 23, 1909.

Concerning the Melville-Macalpine Speed-Reducing Gear for Marine Steam Turbines.

Sir: I note with interest your editorial on p. 519 of the issue of Engineering News for Nov. 11, in which you express grave doubts as to the practicability of the Melville and Macalpine speed-reducing gear for marine steam turbines.

While your reasoning is perfectly sound, it is unfortunately based on unsound premises. In the first place, toothed gearing is not necessarily a delicate thing. Its wide and successful use in heavy rolling mill work in which the stresses are more sudden and severe than in marine work should, I think, be sufficient to exclude this point from further consideration.

In the second place, the assumption that it is impossible to construct a gear which shall be as strong, or even much stronger than the shaft it drives, is far from justifiable. The question as to whether the gear shall be the strongest or the weakest link in the chain, is a matter wholly within the control of the designer.

As to the possible pounding of the gears, it must be remembered that pounding cannot occur without backlash, and in accurately cut gearing the backlash is a negligible quantity.

However, as far back as history goes, every departure from established practice has been confronted with, what seemed at the time, good and sufficient reasons why it should be a failure; and if we may read any lesson at all in history, it is, that in matters pertaining to modern science and engineering, failure is becoming more and more a very unsafe prophecy.

Yours very truly,
H. E. Longwell,
Consulting Engineer.

East Pittsburg, Pa., Nov. 29, 1909.

[If it is practicable to design a toothed gearing to drive the screw-propeller shaft of a large ocean steamer which will be actually stronger against sudden shocks than the shaft itself, then the criticism to which our correspondent takes exception would not hold good. The point to which we particularly desired to call attention, was the difference between the use of toothed gearing on a ship's propeller shaft and its use in ordinary machines. When a tooth breaks in the power transmission plant of a mill the mill shuts down till repairs can be made. On shipboard, however, a broken tooth on a propeller shaft might mean the loss of a vessel, or in the navy the loss of a battle.

The letter which follows, from one of the designers of this speed-reducing gear, indicates that it has been found practicable to make a toothed gear with a margin of strength over the shaft.—Ed.]

Sir: The editorial comment on the Melville and Macalpine reduction gear made in your issue of Nov. 11 was not read by me until a few days ago; but as it raises some questions of the highest importance, I am very pleased that you have given me the opportunity of discussing them publicly.

Both Admiral Melville and I are marine engineers of long experience, fully acquainted with conditions at sea. Therefore, the possible damage from the propeller meeting an obstruction such as a log, or the effect of rough weather with the consequent racing of the propeller, naturally were given very full consideration.

In the design of the Melville and Macalpine reduction gear, which has been built and so successfully tested by Mr. George Westinghouse in the works of the Westinghouse Machine Co., the pitch circle of the large gear is 70 ins. diameter and the hollow shaft carrying this gear is 11 ins. outside diameter and 6 ins. inside. Therefore, the tooth forces are exerted at over six times the radius of the shaft. It is manifest, then, that the teeth are very advantageously placed for stressing the shaft.

Whether we regard the area to be sheared when the teeth fail, or look on them as very short and relatively deep beams submitted to crossbending, calculation shows that they are several times as strong as the shaft. In judging of this strength, it should be remembered that the whole object of the design is to produce continuous line contact along the teeth, under all practical conditions, and the experiments show that this has been accomplished very perfectly. This perfect tooth contact greatly increases the strength over that, for instance, of railroad motor gears which are so subject to errors of alinement, giving rise to point contact of the teeth; in which, consequently, only small parts of the teeth are contributing to the strength at any instant.

But let us apply the ordinary crossbending formula on the supposition that *all* the forces between the teeth are exerted at the points of the teeth—a condition far in excess of the truth and quite impossible in these helical gears. When the gear is transmitting 6,000 HP. and the pinion running at 1,500 r. p. m., the pressure at the tooth contacts is 450 lbs. per lineal in. This applied at the point of the teeth would, by ordinary crossbending formula (which gives an excessive value of the stresses for such short beams), induce a maximum fiber tension of 4,500 lbs. per sq. in. Quite a common commercial steel is used of 70,000 lbs. tensile strength and 35,000 lbs. elastic limit. Thus, from the ultimate strength we have a factor of safety of 15.5 and, from the elastic limit of 7.8, even with the greatly exaggerated conditions. This is an ample margin for all contingencies and probably the actual factors of safety are double these just given. At this power and speed, the torque on the shaft would induce a shearing stress of 5,160 lbs. per sq. in. With this must be combined the considerable stresses due to crossbending of the shaft. Remembering that the shearing stress of the steel is probably not more than 72% of its tensile strength, we see that, even with the unfavorable supposition, the teeth are about 60% stronger than the shaft; and actually, no doubt, two or three times as strong. It should be noted that the shaft is of ample size for a crank shaft transmitting the same torque, in which case it would have much heavier crossbending stresses than in the case of the gear.

An Illustrator's Idea of a Steel Arch.

Again, in thinking of the propeller striking a log or the water, the flywheel action of the large gear and propeller should be carefully kept in mind. This strongly protects the teeth from shock. Compare the case of a rolling mill engine driving rolls through gears, where the load of the engine rises from that due to friction, to full or overload instantly. Even in this extreme case, the shock, which would otherwise be disastrous to the gear, is effectively softened by the energy of the flywheel placed between the gears and the rolls.

Again, the rise of stress to which the teeth are subjected depends not only on the amount of retardation of the heavy flywheel formed by the propeller, shafting, and large gear, but also on the moment of inertia of the turbine and pinion, which are again very elastically connected. If these parts were massless, the teeth could receive no shock.

In the tests, the pinion is driven by a double flow turbine running usually at 1,500 r. p. m. and developing up to 6,700 HP. Suppose a retardation so excessive that it would diminish the speed of rotation of the turbine 10%, or 150 r. p. m., in 1 sec.; in other words, such as would stop the turbine in 10 secs. if continuously applied. Calculation from the actual moment of inertia of the turbine rotor and pinion shows that at 6,000 HP. and 1,500 r. p. m., the steam not being throttled down, the consequent rise of stress in the teeth would only be 33%.

This supposes a very excessive case. Such severe racing would not be allowed. The ship would be run at reduced power and the tooth stress would probably never approach, in such weather, the smooth-water stress due to 6,000 HP.

Further, the high speed turbine allows of a very sensitive governor which, when the propeller begins to race, would at once reduce the power so that when the propeller is re-submerged the steam torque is much below the maximum.

Lastly, we have practically no wear, as the tool marks still show prominently in the teeth. This is partly due to copious lubrication and partly to the well-distributed tooth contact. Hence the life of the pinion will be long, possibly as long as that of the ship. The perfect action of the whole gear is shown by the high efficiency attained which, at 6,000 horse-power, is over 98.5% and probably as high as 99%.

By using a steel of high elastic limit, but still ductile, we have no doubt we could with perfect safety raise the power transmitted by the present machine, which weighs 61,000 lbs., to 10,000 HP. at 1,500 r. p. m.; and there is no indication that this is the limit of peripheral speed at which these gears can be run.

Yours faithfully,
John H. Macalpine.

532 Walnut St., Philadelphia, Dec. 1, 1909.

A Fearful and Wonderful Bridge.

Sir: Behold the latest style in bridge design! The accompanying illustration is from the advance notice of a certain technical paper and purports to be a miniature facsimile of the cover especially designed for the "big Western number" of that monthly. I take the liberty of sending this gem to you, fearing that otherwise it would not meet your eye.

Very truly,
M. E. T.

Minneapolis, Minn., Nov. 27, 1909.

[We present our respects to the Indian. A man with the nerve to hold a plumb-bob steady in the shadow of that arch is wasting his talents as a rear-chainman; he ought to be foreman of a powder mill.—Ed.]

The Profession of Engineering.*

By JESSE M. SMITH,† M. Am. Soc. M. E.

While engineers have existed for thousands of years, it is only within a comparatively recent time that they have begun to form themselves into societies for their mutual education and the advancement of the profession of engineering.

In England, as early as 1771, Smeaton and his contemporaries came together to form the Smeatonian Society of Engineers. The Institution of Civil Engineers of Great Britain came into existence in 1818, and was followed by its sister society, the Institution of Mechanical Engineers, in 1847.

The Société des Ingénieurs Civils de France was founded in 1848. The Verein Deutscher Ingenieure was organized in 1856. The Boston Society of Civil Engineers began its work in 1848.

Our elder sister national society, The American Society of Civil Engineers, was organized in 1852. The next member of the family, The American Institute of Mining Engineers, was born in 1871. Our own society came into existence in 1880, and our younger and very vigorous sister, The American Institute of Electrical Engineers, came along in 1884.

The four greater national societies of America have an aggregate membership at this time of over 19,000 members. Twelve national societies of engineering specialists contain more than 13,000 members. Twenty-three local engineering societies in different cities of the United States count over 8,000 in their membership.

The engineering societies of the country may be likened to the members of a large and harmonious family, each member independent to do its own special work in its own way, each member ready to help each of the others, each residing in its own home, but all ever ready to stand by each other, to work for the common good, to advance and dignify the profession of engineering.

A striking example of the "getting together" of the engineering societies is found in this building which is the home of our society. It is also the home of our sister societies, The American Institute of Mining Engineers and The American Institute of Electrical Engineers.

Under the same roof are grouped together fifteen other societies of engineering and allied arts; 25,000 engineers practicing in all the specialties of engineering may call this building their professional home. We have brought our books together into a single library open to the profession and to the public, where every person is welcome.

The spirit of cooperation which now exists must be fostered, strengthened, made enduring, to the end that as great solidarity will exist in the engineering profession as exists in any of the other great learned professions.

Numbers in membership are, of course, important in the societies which represent the engineering profession, but a high standard of membership is of much greater importance.

In The American Society of Mechanical Engineers, a person may enter the society as a junior upon the presentation of a degree in engineering from a technical school. But this society has not, up to the present, established a standard by which to measure that degree. I believe the standard for such a degree in engineering should be established by the society, and that it should be as high as that of the best schools of engineering in

*Condensed from the Presidential Address at the Annual Meeting of the American Society of Mechanical Engineers, Dec. 7, 1909.

†220 Broadway, New York City.

this country. It will follow that the schools having a lower standard will soon be brought up to the higher standard.

Promotion to higher grades of membership in our society is only made upon a showing of engineering experience satisfactory to our membership committee. This committee is maintaining a high standard of membership.

If we are to have a profession of engineering, as distinguished from the trade of engineer, we must have a broad education befitting men of a learned profession, as distinguished from a narrower education sufficient for men of a trade. President Lowell, of Harvard, in his recent remarkable inaugural address, gave this as his conclusion: "The best type of liberal education in our complex modern world aims at producing men who know a little of everything and something well." If that conclusion be true of a liberal education leading to the learned profession of the law or medicine or theology, why is it not also true of a scientific education leading to the learned profession of engineering?

Enthusiasm and devotion to his profession is characteristic of the engineer, and from my observation these begin with the student in engineering and extend right through his life. President Wilson, of Princeton, in an address at Harvard not long since, dwelt upon "the chasm that has opened between college studies and college life. The instructors believe that the object of the college is study, many students fancy that it is mainly enjoyment, and the confusion of aims breeds irretrievable waste of opportunity."

These conditions, I believe, exist to a much smaller extent in the technical schools, where engineers are taught, than in the general colleges, where a liberal education is obtained.

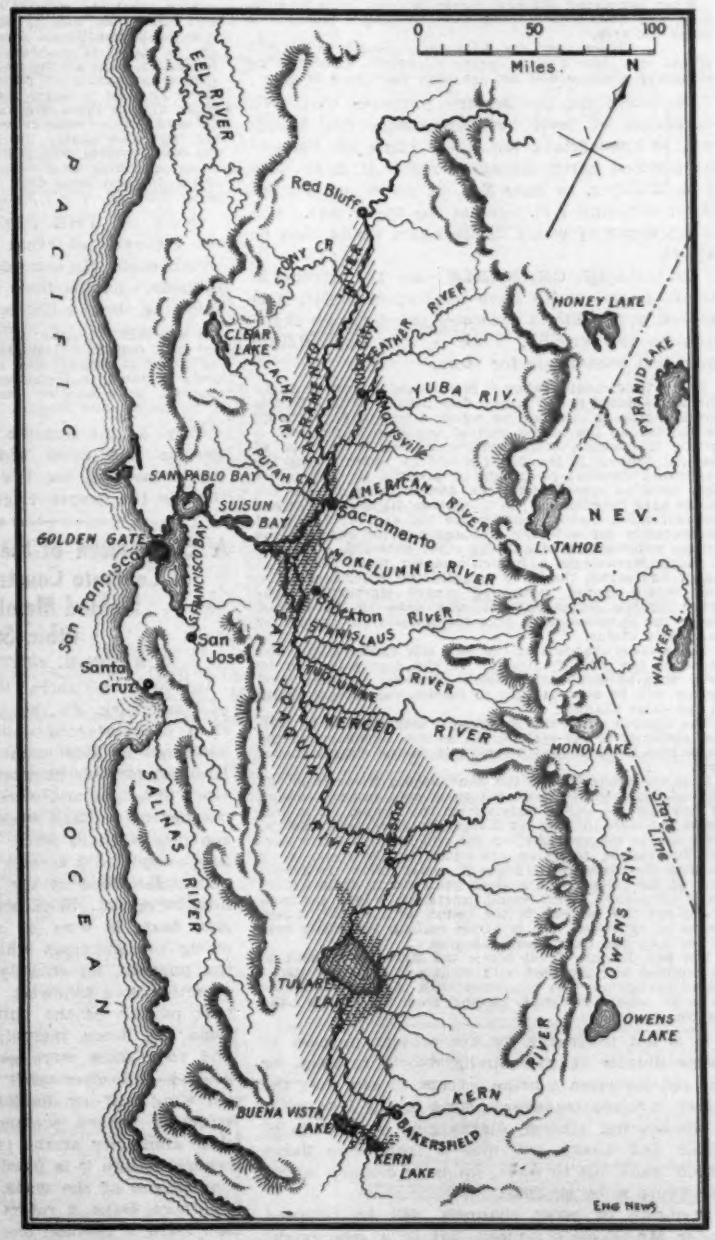
Where enthusiasm exists, love of work exists; success follows. Our individual enthusiasm is quickened by the study of the work of our brother engineers. What engineer while being whisked through the tunnels which connect Manhattan Island with the lands surrounding it, can fail to rejoice in his profession as he contemplates the work of the civil engineers, the mining engineers, the mechanical engineers, the electrical engineers, which joined together supplement each other to produce success in those marvelous undertakings? The highest knowledge and skill in each of the four branches of the engineering profession were called for and were forthcoming, in the consummation of this great work.

The American Society of Mechanical Engineers has before it a future of usefulness to its members, and influence in the profession, which is unlimited. It only requires that we stand by our tradition of increasing the membership with men of high quality as engineers; that the members maintain enthusiastic devotion to good professional work; that they cooperate with each other in the broadest and most friendly spirit to produce that solidarity of membership, and devotion to high ideals, which will compel the world to class the profession of engineering with the other learned professions.

THE MINERAL PRODUCTION OF THE UNITED States in 1908, according to a bulletin issued by the U. S. Geological Survey, showed a decline in value of 23% from that of 1907. There was a general decrease in the output of both metallic and nonmetallic products. The production of iron ore decreased 30% in quantity and 38% in value; pig iron, 38% in quantity and 52% in value. The bituminous coal production decreased about 16%.

Flood Prevention and Land Fertilization by Basin Irrigation in the Sacramento-San Joaquin Valley.

Sacramento, the capital city of California, has just appropriated a sum of money in the undertaking of straightening and widening the lower part of the Sacramento River in order to lower the flood levels and protect the city against inundation. The State is joining in this work, and local sentiment is in favor of asking Congress to vote an appropriation for the same purpose. The flood situation in Sacramento is recognized to be serious enough to call for prompt action. Present proposals involve an expenditure nearing a million dollars.



SKETCH MAP OF MIDDLE PORTION OF CALIFORNIA, SHOWING AREA COVERED BY FOOTE'S BASIN IRRIGATION SCHEME.

A very different solution, based on a much more alarming view of the situation, is offered by Mr. A. D. Foote in a paper which appears in the September "Proceedings" of the American Society of Civil Engineers. His description makes the proposed work seem quite futile. His plan is distinguished among flood-prevention schemes because it includes a project for agricultural regeneration, as one of its central elements. An abstract of his argument and his scheme is therefore given here.

In connection with this it is interesting to read the extended report of W. B. Clapp, E. C. Murphy and W. F. Martin on the flood of March, 1907, in the Sacramento-San Joaquin Valley, Transactions of the American Society of Civil Engineers," Vol. LXI (July-Dec., 1908), pp. 281-376. The 1907 flood was by far the greatest in several decades, in fact the authors of the report consider it an extraordinary maximum. Mr. L. Wagoner, however, in discussing the paper told of finding signs of a very much higher flood, which he places in 1862.

The remarkable fact is established by the report mentioned, that the 1907 flood was from two to three times as great as the highest estimates made only three years before by an expert commission of engineers. This commission was specifically charged with recommending flood protection works. Had its findings been acted upon at once, the protection works would have proved utterly useless in 1907. This emphasizes forcibly what an extravagant safety-margin must be allowed in flood calculations in view of the short period of recorded rainfall and flow data, especially in such a region as California.

Returning to Mr. Foote's paper, we may recall that the interior of California forms a long flat valley, extending north and south well over half the length of the State. At midlength the western border of this valley is broken by Suisun Bay. The north half is drained by the Sacramento River, flowing south; the south half by the San Joaquin, flowing north; these two rivers make nearly a straight line up and down the valley. Streams coming down from the mountain chains to east and west feed these rivers.

The largest tributary of the Sacramento is the American River, which flows in from the east not far above its mouth. The city of Sacramento occupies the southeasterly corner at the junction. The American is fed from the eastern mountains, while the basin of the upper Sacramento extends far up into the northern counties. Their relations as to producing floods are strikingly described by Mr. Foote in introducing his project:

> During the winter of 1908-9 it so happened that the first heavy rains fell on the watersheds of the American and Yuba rivers. The American rose until the levees on the east side of Sacramento were but 6 ins. above the river surface and the bridges of the Southern Pacific and Western Pacific railroads went out, though the Sacramento River on the north side of the city was 2 ft. below the high-water mark. The heavy rainfall then shifted to the northern counties, and in a few days the Sacramento River was higher than ever before known, though the American River had gone down. Few realize what good luck it was for Sacramento City that the flood came down the American first. Had the heavy rains fallen in the northern counties first, the crest of the flood would have reached Sacramento about in time to meet the crest of that from the American River. The levees east of the city would have gone out, and the whole American River, swelled by the backwater from the Sacramento, would have swept the city, a mass of wreckage, drifting toward the Bay. A few of the stronger buildings might have stood, but probably the American River channel would now be in front of the Capitol.
>
> It is not known why the rains came to the American River first, but it is known that it is merely a question of time when the laws of rainfall will swing the rains to the northern counties first and the American afterward, and things will happen as above described.
>
> There can be no reasonable doubt but that the floods in the Great Valley will continue at irregular intervals, and the time will come when the combination of the rain conditions will be such as to destroy, at different times perhaps, every town and village on its lower levels. No levee system alone can be built that will withstand the great floods.

In connection with this quotation it should be noted that the channel improvement work now projected by Sacramento City is to deal chiefly with that part of the river lying below the city. Mr. Foote indeed refers to the bad condition of the lower reaches of the river (and also of the San Joaquin), in the following words:

> The two great rivers, which should be 6 to 10-ft. channels, reaching from Red Bluff to Lake Tulare and from Marysville to the Bay, are shallow sloughs through which a few flat steamboats and barges struggle from one sandbar to another below Sacramento and Stockton. Fifty years ago they were of immense value to the community as commerce bearers, and, though not large enough to carry the highest floods, they were of vast importance in ameliorating them.

The navigation interest, it appears, is sufficiently important in Mr. Foote's judgment to merit being included in a comprehensive scheme of river control. Much more important, however, are the two other elements, namely, irrigation and land fertilization, together with drainage as a third associated element.

The Great Valley has a rainfall generally under 20 ins. per year, and is thus rather dry, and needs irrigation. The surrounding mountains have much higher annual rainfall, varying from 20 to 60 ins. The water which they send down

into the valley is ample to make up the deficiency there, if properly used for irrigation. On the other hand the alluvial river-plain has large areas of low or swamp land, for whose reclamation thorough drainage is essential. Finally, the fertility of the agricultural land in the valley, originally very great, is appallingly reduced at present through unscientific farming. This latter situation is so graphically expressed in Mr. Foote's paper as to demand quoting:

The Great Valley of California, as nature built it, by filling an inland sea with debris from the hills, seemed capable of feeding the world with wheat 50 years ago. Fifty years of mishandling natural riches and spurning natural laws have so far injured it that now it may be said, in an economical or engineering sense, the Great Valley is lost to the world. The historic wheat fields have deteriorated until they are no longer of appreciable value to the state. When Mr. Davis, after whom Davisville was named, sat on his housetop and with a spyglass watched his plow teams crawl over his vast wheat fields, he expected a harvest of 40 bushels to the acre. A member of Balfour, Guthrie & Co., the great wheat buyers of the Pacific Coast, recently said that those same fields would now produce from 6 to 10 bushels only, and that of an inferior wheat. Even the mills are obliged to import wheat into California and mix it with the native crop to bring their flour up to grade. Fifty years of crops with no fertilization has made the Valley of almost no economical value.

On these facts Mr. Foote has developed a river improvement scheme unique in America.

IRRIGATION BASINS.—He proposes dividing up the entire alluvial area of the Sacramento and San Joaquin valleys into a series of basins by dikes parallel to the general land contours, with regulated inlets where each basin flanks upon the river. When the winter high-water approaches these basins are to be allowed to fill, flooding the ground to a depth of several feet, and creating a storage great enough to prevent any extreme flood rise. So far, then, the scheme disposes of the flood problem.

The water is to be left in the basins long enough to deposit all its silt, and thoroughly soak the ground in addition. Thus irrigation and fertilization are accomplished. Then the basins should be drained.

DRAINAGE CHANNELS.—To accomplish this, independent of the river stage, the project includes as essential elements a drainage channel paralleling the river on either side, some distance from it, occupying the lowest ground so far as possible. The openings of the basins into these channels would be controlled by gates. The channels are intended also to drain the marshes.

MOVABLE DAMS.—For more complete control of water distribution the two main rivers would have movable dams at intervals; navigable depths would thus be created, and locks at the dams would pass vessels up and down.

DEBRIS BARRIERS.—To protect the river system from the inflow of large volumes of mining debris Mr. Foote proposes to build debris barriers in all the mountain streams at a number of points. While the barriers built by the State Debris Commission in the Yuba have proved failures, he believes that with different construction and location their security and permanency may easily be assured.

A notable auxiliary of this phase of his scheme is the plan to intercept the soft silt which flows along the bottoms of the mountain streams, and distribute it upon waste lands and into low areas, to produce new fertile agricultural lands.

Mr. Foote also holds that with proper management of the debris barriers, placer mining (now prohibited) may be resumed without injury to the streams and with profit to the State.

These various auxiliary elements, however, stand and fall with the irrigation and reclamation feature of the scheme. The argument for the latter needs nothing further, perhaps, after the above quotation regarding the ruined fertility of the Valley, but a paragraph comparing the state of the Valley to that of Egypt may be interesting:

No one appears to have realized the great physical and climatic similarity between Egypt and the Great Valley, nor how perfectly the basin system of Egypt adapts itself to and solves the problem in California. Except where perennial irrigation obtains, both countries are limited by the climate to one short-season crop, generally some food grain, and, as far as can now be judged, this limitation will always hold.

The Egyptians welcome the muddy flood, and gently spread it out over the valley under perfect control, keeping it until it has watered and enriched the land, and then sending it quietly to the sea. Sowing the grain upon the ooze when the water has barely left it, their crop comes to maturity without other aid. Contrast this with placing dependence on a precarious rainfall to grow an inferior crop on a deteriorated soil, and unsuccessfully fending off the flood in terror lest it destroy the country.

This self-same system, therefore, is to reclaim the Great Valley. Only, as the California rivers will not usually fall soon enough to drain the basins for seasonable cropping, the lateral drainage channels must be added to the scheme.

Chief Details.

BASINS AND DIKES.—The arrangement of the basin dikes along the contour lines will in both the Sacramento and the San Joaquin valleys produce very long, narrow basins. These are to be cut up by partition dikes:

When completed, the basins may be from 10 to 20 miles long, and from 1 to 3 miles wide, forming a manageable shape and area.

. . . When they are filled there should be a depth of not less than 2 ft. of water anywhere, otherwise the shallower portions will not get their due share of silt.

Assuming for preliminary purposes that 5-ft. difference of level between consecutive basins will be appropriate, Mr. Foote plans his dikes to be puddled earth embankments 9 ft. high with 1 on 2 slopes, to have 2 ft. of water against the lower side and 7 ft. against the upper side. The mean depth of water in the basin would then be 4½ ft.

DRAINAGE CHANNELS.—As the rivers in their alluvial plains have built-up channels, it is generally feasible to construct the drainage channels on low ground. Only a very approximate plan has been made for them.

In the Sacramento Valley it is proposed to use the Cache Slough, widened to the proper dimensions. With a bottom grade beginning at mean low water, a wide channel should be carried up the lowest part of the Yolo Basin, with a grade, if possible, which will give from 4 to 6 ft. of natural banks. If feasible it would be better to use the excavated material for filling or leveling up low places and have no spoil banks, the design being to use the whole area between the 10-ft. contour dikes as an escape channel when desired, and to use the excavated channel permanently for ordinary drainage and for carrying the excess water of Cache and the other west-side creeks.

Above Sacramento a branch channel must be carried under and across the river to drain the American Basin, and should extend northward toward Marysville. Another branch escape-channel will have to be carried under the Sacramento to take the water from the Sutter and Butte basins.

The present channels on the west side of the valley, and those of the smaller streams on the east side, can be used both as escape and feeder channels, as their flood season will be over in time to receive the escape waters in the same channel.

The siphons under the Sacramento may seem to be serious obstacles to the system, but on due consideration the objections to them may be reduced to the simple one of cost. . . .

It is not probable that the San Joaquin River from the Merced down can be depended on to subside soon enough to carry off the escape waters from the basins. It is proposed therefore to carry an independent channel up on the west side to intercept the San Joaquin just above the Merced and thence, following and enlarging the river, to its bend to the eastward. Thence it would follow the lowest part of the valley, with a slope sufficient to drain Tulare Lake completely. This would necessitate a long cut from about the 190 contour to the center of the lake, which would be expensive, but it would reclaim the whole area of the lake and its swampy margins.

The San Joaquin River below the Merced will need to be rectified and provided with dams and locks for slack-water navigation, and connected with the upper channel so as to make a navigable channel from the Bay to Lake Tulare.

It is not necessary for the present purpose to quote details of the mining debris barriers, or the silt-diversion scheme, except to say that the latter involves transverse slots in the bottom of a silt-bearing stream, discharging a mixture of water and heavy silt into a transverse flume which leads out to waste lands or sloughs where the filling is to be done.

Dredging of river channels will be required under Mr. Foote's project, but to a less extent than necessary for flood-protection under present conditions. From Cache Slough (on the Sacramento) to the Bay, however, the dredging must be as extensive as now needed.

OPERATION OF THE SYSTEM.—What the system above described would accomplish, in its primary purposes and flood-control, is described briefly as follows:

Assume the heaviest flood conditions ever known as sure to come in the Sacramento Valley, and imagine the basin scheme complete. It is believed that the operation would be as follows: In the beginning of the flood, the regulating dams would be closed, the feeder gates open, and the basins filling. Ordinary judgment would imply the opening of the escape gates somewhat before the basins were full. As the floods rose, the regulating dams would open, to pass the excess down the rivers. The floods still rising, until all escape gates are wide open, all dams down, and the rivers full, there would still be room in the basins for considerable excess, until their limit was reached. In this condition, the flood capacity of the river and escape channels would be somewhat more than 100,000 cu. ft. per sec., greater than was ever required in the Valley.

It is reasonable to assume that these conditions would not continue long, and would not occur later than March. Very soon the feeder gates would be closed and the rivers would be carrying the falling flood. The escape channels would drain the basins rapidly. Sowing could begin in the higher basins by the middle of April, and all by the first of May. This may be thought to be late for a good wheat crop, but it must be remembered that a heavy flood in the Valley means a heavy snowfall in the mountains and a long snow flood, so that a late sowing of the crops is compensated by a late irrigation, that is, that the feeder gates will be opened again near the end of June, and the crop will then get a heavy irrigation at the time of the hot winds of late June and early July.

From the foregoing it may be seen that a flood 25% greater than that of 1862 could pass through the Valley, not only without injury, but with vast benefit to the crop which would surely follow.

Assume the conditions in an extraordinarily dry season: Unfortunately, knowledge in reference to the weather is not yet sufficient to predict, at the beginning of the winter, what the rainfall is to be, but, in any event, it will always be well to begin turning the muddy water into the higher basins as soon as it comes; and, if there are no rains of consequence following, by closing the regulating dams all the water there is can be utilized and spread as equably as possible over the basins and give them at least a short soaking. Early sowing will be made, and, as there is always some snow flood, it may be all used for the summer irrigation early in June by closing the dams again. In the extra dry year, therefore, the basin system will utilize all the water there is, and make something of a crop, though the land will not get much silt, and must draw on its previous enrichment to carry its crop.

COST OF THE PROJECT.—Mr. Foote makes no estimate of what his reclamation scheme would cost. He concedes that it "will cost many millions," but he finds ample returns to warrant spending these millions. Again he says:

It will take a number of years to complete the scheme, and may require $75,000,000, which can be borrowed by the State as needed and returned to the State by the lands benefited, in instalments, after the benefit has been received, in a manner similar to that followed by the U. S. Reclamation Service.

Only, as the benefits in this scheme are more various and more widely distributed, the apportionment of the tax would be more complex than in the simple irrigation undertakings.

A Comparison of the Cost of Two Methods of Concrete Construction: Separately-Molded Members vs. Monolithic Structure.

By MASON D. PRATT,* M. Am. Soc. C. E.

In 1904, the Central Pennsylvania Traction Co. of Harrisburg, Pa., built a car barn and a repair shop of reinforced concrete, probably the first buildings in this country built entirely of this material for this purpose. The buildings are one story in height and were constructed in the usual manner by erecting wooden forms and casting all concrete work in place. The same company has just completed a second barn adjacent to the one above described of the same dimensions as the first barn, viz., 75 ft. wide by 360 ft. long. The last barn is also of reinforced concrete, but owing to conditions which seemed favorable for the purpose, an entirely different mode of construction was followed. All of the members for that portion of the building above the foundations and floors, including columns, beams, wall and roof slabs were separately molded on the ground and afterwards erected by means of a traveling stiff-leg derrick. This method of construction proved economical and owing to the close similarity of the two buildings in size and general design it is possible to make an accurate comparison of the costs. In describing the two buildings, Barn A refers to the original building and Barn B the last one erected.

Barn A was built on ground which was from 2 to 10 ft. below the floor level. The column footings were placed on solid ground 6 to 12 ins. below the sod and carried up within 1 ft. of floor level, the ground being filled in after the building was under roof. In general plan the building had three rows of non-reinforced hexagonal columns spaced 15 ft. centers longitudinally and 37 ft. centers transversely. The roof consisted of transverse beams, resting on the columns, longitudinal purlins and a 3-in. slab cast in place, the columns being connected longitudinally with beams 6 ins. thick and 2 ft. deep. After the forms were removed from this skeleton, the three longitudinal walls were filled in place. Provision was made for future extension laterally by casting brackets in the columns to support roof girders for an adjacent bay. The barn also had a

*Engineer, Harrisburg, Pa.

wing 16 ft. wide and 90 ft. long, containing barn foreman's office, lockers and lavatory for the use of motormen, conductors and barn men.

Concrete for this building was mixed in a rotary batch mixer, into which the aggregate was dumped directly from wheelbarrows and the concrete distributed from the mixer to the job in wheelbarrows by means of runs and an elevator operated by a power hoist.

Barn B (Fig. 1) was built entirely independent from Barn A, the first wall being placed 37 ft. beyond the wall of Barn A, thus permitting the increase of the plant by one additional bay in the future by simply adding a roof between the roof beams. Two slabs at the center of every alternate 10 ft. bay were omitted to allow placing skylights. The walls were 6 ins. thick, as in the case of Barn A, but were made up of slabs of various sizes (Fig. 2). These slabs were all tongued-and-grooved, as were also the columns. Three-eighths of an inch was allowed for all joints, the horizontal joints being mortared as the work at every other column, while on the center wall each column carried a beam and a longitudinal beam between columns supported the ends of two roof beams. The roof proper consisted of slabs, 3½ ins. thick, 10 ft. long and 6 ft. and 7 ft. wide (Fig. 4), which were laid directly on the

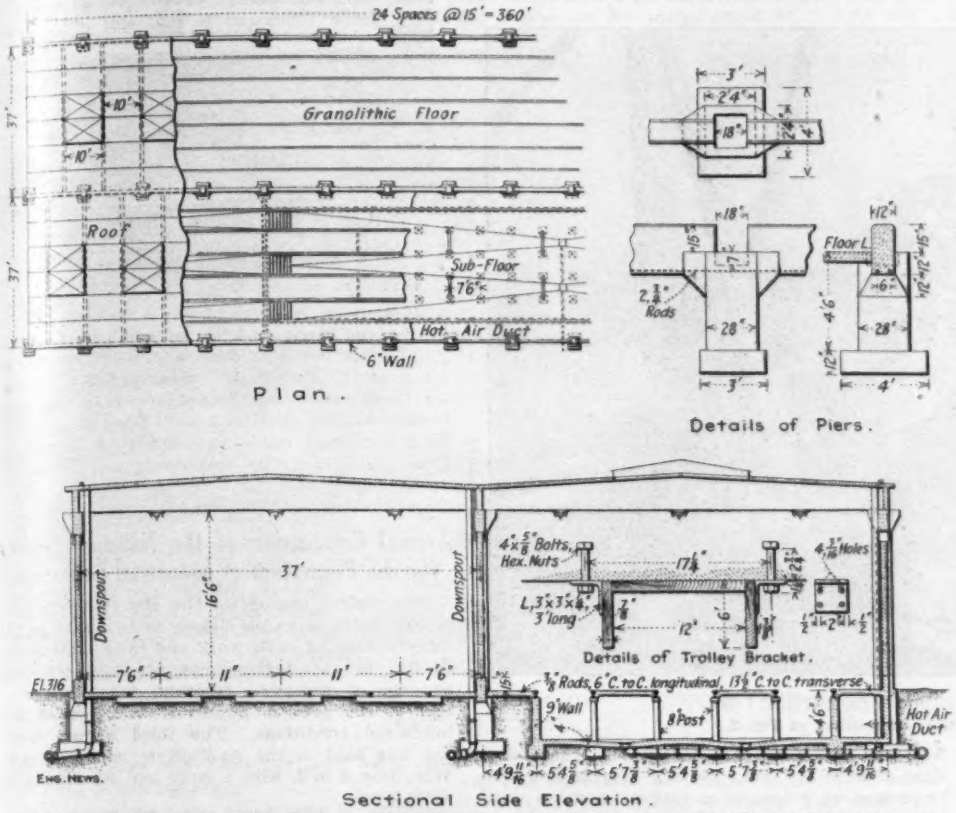


FIG. 1. PLAN AND ELEVATION OF CONCRETE CAR BARN ERECTED WITH SEPARATELY MOLDED MEMBERS.
Central Pennsylvania Traction Co., Harrisburg, Pa.

the same mixer used on Barn A, located at a central point, the materials being moved in wheelbarrows as before.

Barn A had about 290 ft. of open pits under each track, 60 ft. of the front end of each bay being paved with granolithic floor and used as space for washing cars. Barn B had the same arrangement in one bay, the other bay, which was intended for storage purposes only, had granolithic floor from end to end. The ground on which Barn B was built had been filled in with various materials, mostly cinder from a nearby steel plant, and excavations had to be made for all foundations. In the figures given below, all labor for excavation in both buildings is omitted. In Barn B, each column had a separate footing as in Barn A, which, however, was carried to a point 15 ins. above floor level, and provided with a pocket to receive the column. A layer of sand was put in each pocket to give the column good bearing and to adjust height. A beam 12 ins. wide and 2 ft. deep connected these footings, being cast at the same time with the footings.

The tracks were laid in the storage bay and the granolithic floor cast in place at the time of starting excavations for the foundations, and as soon as this floor was in place the casting of beams, columns and slabs began. The beams and columns were nested by casting the alternate pieces a suitable distance apart, and after removing the forms these became the forms for the intermediate pieces. The slabs were cast in piles, the ends being offset to enable rapid handling. The pieces were separated by means of 40-lb. waxed manila paper. No difficulty whatever was experienced during erection in separating. In some instances soap was used, but the results were not as satisfactory and the cost was higher than with the paper. The surface of the pieces formed by paper separation showed a close, smooth, dull surface, except for the wrinkles formed by the paper, which was not heavy enough to prevent wrinkling. The paper was also responsible for other defects in the surface finish, owing to the mortar running in between joints where the paper overlapped and forming thin slivers. The paper was easily removed with water from a 1-in. hose, with nozzle ¼-in. The top surfaces of all pieces, of course, were troweled. This gave a rather variegated wall surface to the structure, but a coat of cement wash using a thin mixture of about equal parts of cement and limestone dust applied with whitewash brushes produced a fairly uniform appearance. This method of construction involved the

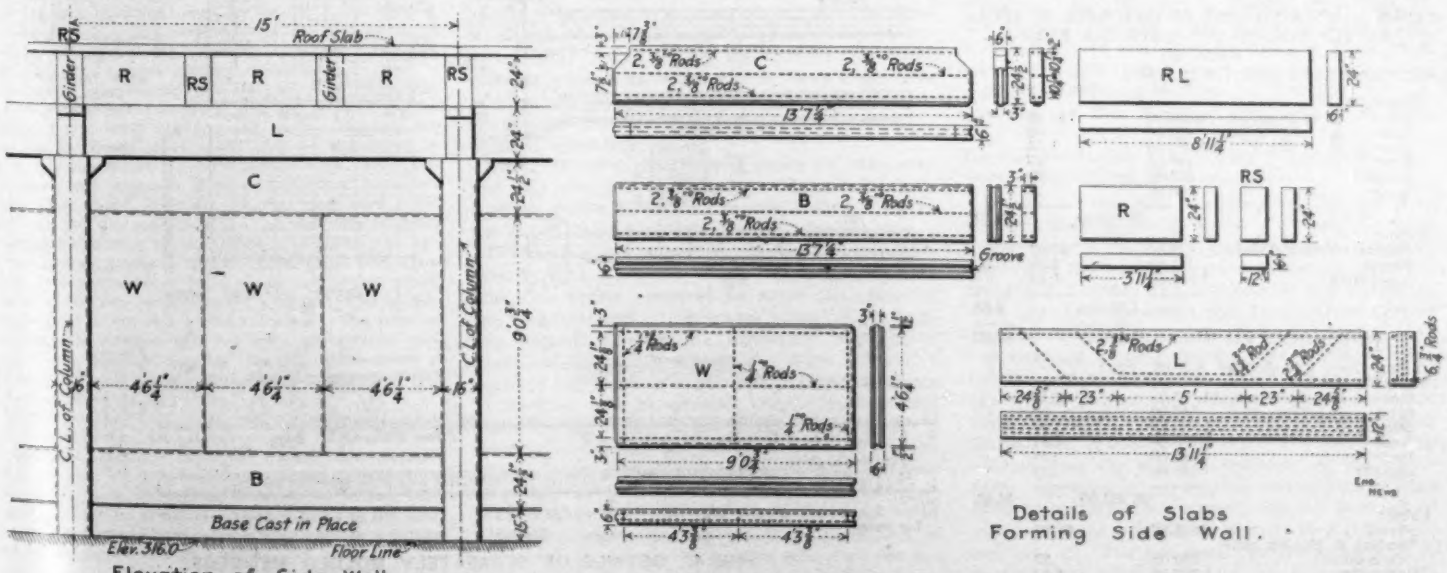


FIG. 2. POSITION OF PIECES IN THE BUILDING AND DETAILS OF SOME OF THE MEMBERS.

two buildings. Column spacing was made the same as Barn A, but the columns were square. In order to get roof slabs of a size which could be conveniently handled, the roof beams were spaced 10 ft. centers and alternated in the two bays. Thus on the outer walls a roof beam came

The concrete for this building was mixed in

use of slightly more reinforcing steel and a larger yardage of concrete, but the saving in forms, lumber and carpenter work was more than sufficient to pay for this difference and the additional cost of derrick and erection labor.

The number of loose pieces required was 1,400.

These were completely erected in 33 working days, with a loss of only three slabs from breakage.

The derrick used was a standard stiff-leg with 60-ft. boom and 38-ft. mast, mounted on a truck so that it could be moved around the work. Power was furnished by a regular street railway motor through a gear bolted to the flywheel on the driving shaft of a two-drum hoist, the motor being equipped with standard street railway controller and suitable resistance coils. A Traction Company motorman operated the hoist and a rigger crew placed the material. The heaviest pieces handled were the roof beams, which weighed 7½ to 8 tons. A number of special devices were used to handle the various pieces. For the heavy beams a loop was formed at the quarter points by bending a reinforcing rod, bringing it flush with the top of the beam and scooping out a portion of the concrete while green and a special hook used to engage this loop. These hooks entered the slotted ends of a steel spreader. The rig was thus adjustable for variable spacing of the loops and for balancing. The slabs were handled by means of slings, holes being formed in the slabs with a short section of ¾-in. gas pipe for receiving bolts. In setting up the side walls, these holes were used to fasten

FIG. 3. VIEW OF BARN B DURING CONSTRUCTION.
(Compare position of various pieces with letters on Fig. 2.)

3 × 4-in. sticks on each side of the three wall slabs of each bay, thus keeping them in line and, by means of props, in a vertical position until erection had proceeded far enough to remove them. Fig. 3 shows these sticks in position.

Table No. 1 gives complete detailed cost of all the concrete work in Barn B.

Table No. 2 is a comparison of the average costs of all the concrete work on Barns A and B, the figures covering all charges except general supervision. The concrete aggregate is put at same figure in each to eliminate any difference in unit cost of these materials. The mix was practically the same in each, the largest percentage being 1:2:4. Unit costs for labor were the same in both cases; viz., ordinary labor, $1.35 per day and carpenters, $2.50 per day.

It will be noted more steel was required in B but very much less form material and labor. The roof of Barn B required more concrete, as all beams and slabs had to be treated as simple members, whereas in Barn A full advantage was taken of the T-sections. Making full allowance for these differences the actual cost of the concrete structure of Barn A over Barn B was 15%. Both buildings were constructed by day labor from plans made by the writer and under his direct supervision.

TABLE I.—SHOWING COST OF CONCRETE IN SEPARATELY MOLDED CONCRETE CAR BARN.

BARN B.

	Total.	Per cu. yd.
Foundations and Floors, 710 cu. yds.:		
Materials:		
Stone @ $1.28 cu. yd...	$856.00	$1.20
Sand @ 1.30 cu. yd...	432.00	.61
Cement @ 1.15 bbl.....	1,082.50	1.53
Steel	120.00	.17
Lumber	633.00	.89
Tools	100.00	.14
	$3,223.50	$4.54
Labor:		
Placing reinforcement...	$19.00	$0.03
Forms	771.00	1.09
Concreting	1,015.00	1.43
	1,805.00	2.55
Total materials and labor ...	$5,028.50	$7.09
Building above Foundations, 948 cu. yds.:		
Material:		
Stone @ $1.28 cu. yd..	$1,085.00	$1.16
Sand @ 1.30 cu. yd...	546.00	.58
Cement @ 1.15 bbl.....	1,735.00	1.86
Steel	1,755.00	1.87
Tools	140.00	.24
Lumber	220.00	.15
	$5,481.00	$5.86
Labor:		
Forms	$818.00	$0.87
Bending & placing reinforcement	360.00	.39
Concreting	1,152.00	1.23
Erection	1,776.00	1.80
Pointing & cement wash	617.00	.06
	4,723.00	5.04
Total labor and material...	$10,204.00	$10.90
Totals, 1,648 cu. yds.....	$15,232.50	$9.245
Area covered by building, 360 × 75 ft. = 27,000 sq. ft.		
Cost of foundations and floors.....	18.5 cts. per sq. ft.	
Cost of building	38.0 cts. per sq. ft.	
Total	56.5 cts. per sq. ft.	

TABLE II.—COMPARISON OF COST BETWEEN CAR BARNS, SEPARATELY MOLDED AND CAST IN PLACE.

(Average including Foundations and Superstructure.)

Materials:	Per cu. yd. Barn A. (Cast in place.)	Per cu. yd. Barn B. (Separately molded pieces.)
Stone, sand and cement...	$3.480	$3.[illegible]
Steel reinforcement.....	.915	1.[illegible]
Lumber	1.335	.[illegible]
Paper	....	.[illegible]
Tools, wheelbarrows, etc...	.145	.145
	$5.875	$5.285
Labor:		
Carpenters	$3.250	$0.[illegible]
Bending and placing steel..	.095	.[illegible]
Concreting	2.210	1.[illegible]
Erection	....	1.[illegible]
	5.555	3.960
Total cost per cu. yd.....	$11.430	$9.245
	9.245	
Dif. in favor Barn B.....	$2.185	

Annual Convention of the National Society for the Promotion of Industrial Education.

This society has as its aim the technical education of the working classes with a view to the improvement of their work and their earning capacity, to the development of those who are capable of becoming foremen, inspectors, etc., and to the general improvement of social and industrial conditions. The third annual meeting was held in the Auditorium, at Milwaukee, Wis., Dec. 2 to 4, with a large and representative attendance.

The convention opened with a dinner at which several addresses were made dealing with various aspects of the question. The President, Mr. Alexander C. Humphreys (Stevens Institute of Technology), dealt with the subject of "The Economic Value of Industrial Education." He stated that of 13,000,000 young men between 21 and 35 years of age only 5% receive in the schools any direct preparation for their vocations, and he expressed the opinion that the public-school system of this country has been developed for the few rather than for the benefit of the masses, while its development should have been in the opposite direction, as the few can be provided for by less wasteful methods. Dr. George H. Martin, formerly Secretary of the Massachusetts

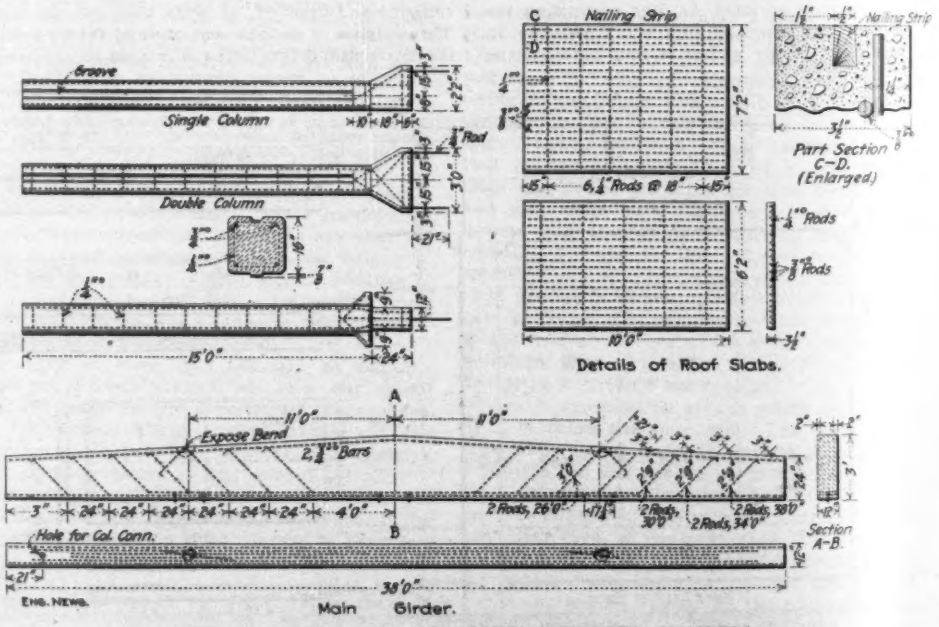


FIG. 4. DETAILS OF SEPARATELY MOLDED MEMBERS.

State Board of Education, took the view that financial aid for industrial education must be rendered by the state government, even in the wealthiest states.

UNIVERSITY AID IN INDUSTRIAL EDUCATION.—Dr. C. R. Van Hise, President of the University of Wisconsin, dealt with the new development in this line of education which has been taken up by this university, and we quote below some of his remarks:

In this country the trades school must be developed upon a far reaching scale; but as yet such schools scarcely exist. The rapid advance of applied knowledge and the absence of trade schools have made it advisable for universities to give aid in industrial education. This has been done at the University of Wisconsin (and to a lesser extent at other universities) by the establishment of the extension divisions. The extension division of the University of Wisconsin gives information by lectures, by institutes and by correspondence in many industrial lines.

The correspondence schools, established upon a commercial basis, have led the way, but their chief defects have been that each man must work by himself and that he does not come in contact with his teacher. The inevitable consequence is that comparatively few men have the stamina to continue long in study. The great majority drop out of the courses which they begin.

Realizing these defects the University of Wisconsin has handled its correspondence work for artisans so that groups of men work together and meet a teacher, the traveling professor. This could only be successful by the cordial cooperation of the manufacturers. The manufacturers, and especially those in Milwaukee, have furnished class rooms in which the men may meet. Not only this, but they pay their men for the time they are receiving instruction, an hour once a fortnight.

The traveling professor and the class-room work place study by correspondence upon a new and higher plane, and under the new conditions the great majority of students persist to the end of their courses. The work of our extension division has met with enthusiastic support in this state and pending the wide development of the trade school it is the best method yet devised to give industrial education.

Even when the trade school is fully developed, as it will be in the future, the extension work for artisans will be continued. Men need a broader training than a simply vocational one. It will be the aim of the University to continue to teach the artisan after he leaves the trade school, not only in advanced studies relating to his vocation, but in studies which concern his duties as a citizen, and which concern him as a man.

In this connection it is of interest to note that nearly 20 manufacturing firms in Milwaukee furnish class rooms and give the men time (with pay) for attending the classes. Mr. K. G. Smith, who was until recently Assistant Professor of Mechanical Engineering at the University of Illinois, has been put in charge of the University of Wisconsin's "extension" work in Milwaukee.

At the morning meeting on Dec. 3, Mr. Arthur D. Dean, Chief of the Trades Schools Division of the New York State Department of Education, presented a paper on "State Legislation for Industrial Education," taking the position that this is a matter for the state rather than the Federal Government. In his opinion the problem of such education ranks with those of state-aided canals and roads, or the conservation of forests and water power. The state should have supervision of this education, as it has of hours of labor, ventilation and safety in shops, and other industrial conditions. It is a matter for the state and not for the community, but local enterprise and responsibility must be developed also. The trade, industrial and agricultural schools should be close to the people, and their control in the hands of the state boards of education. School laws and factory laws must work together, and the state can formulate a plan which will receive the cooperation of both the employer and the employee. The trades school is not to be regarded as a reform school (which is a view sometimes taken), nor is it for indiscriminate use; it is intended (like the high school) for those who need it and are capable of profiting by its instruction. He expressed the opinion that agricultural colleges have got rather away from their original purpose, and care must be taken that a similar development does not take place with industrial education.

FIG. 5. VIEW OF CASTING YARD DURING ERECTION OF BARN B, CENTRAL PENNSYLVANIA TRACTION CO.

TRADES SCHOOLS.—In a paper on this subject, Mr. Charles F. Perry, Director of the Milwaukee Public School of Trades (now a part of the city's public-school system), stated that a new problem for school boards is the provision of industrial education which will make the boys and girls better prepared to enter the ranks of the bread earners. In a trades school, a boy who has passed through the necessary preliminary grades of the public school, can learn more of a trade in one year, than he can learn in four years by working in a commercial shop. He can command higher wages at an earlier date, and he is much better fitted for advancement. Shop discipline must prevail, and the work must be done as nearly as possible on a commercial basis, so that the boy will not only learn the work itself but will realize also the practical conditions of the work. Too many boys leave school at the age of 14 for various personal or economic reasons, and the trades school should offer them an inducement to continue their training.

Mr. Lewis Gustafson (Superintendent of the David Rankin School of Mechanical Trades at St. Louis) read a paper upon similar lines, and Mr. William C. Smith (General Director of the Winona Technical Institute at Indianapolis) dealt with the limitations of trade work in schools. In order to give the boys a better understanding of the commercial aspects of their work there should be some cooperation between manufacturing establishments and the schools. The foundry at the Winona school makes castings for several firms, and the boys are paid for their work. The boys also have done electric wiring, bricklaying, etc., and those in the latter trade have been given enough work on actual commercial construction to be able to take their places with regular workmen on a job. Mr. Fletcher (Rochester Mechanics Institute) remarked that the boys at that school make furniture for the public schools and do electric wiring, etc., in the school buildings. The desirability of industrial education for girls, and the great scope of work for women and girls as wage-earners (apart from work in the home) were presented by Mrs. Raymond Robins, of Chicago, and Miss Anna Hedges, of New York.

Mr. Joseph J. Eaton (Director of Trades Schools at Yonkers, N. Y.) described the textile school organized and maintained by the mills at Ludlow, near Yonkers, a mill town. The pupils spend five hours a day in the mill and three hours at school, receiving pay for the eight hours. They work in pairs, alternating between the mill and the school, so that the work of the mill is not interfered. Some of those who have worked for three years are found to have a broader knowledge of the work than many of the older foremen, who know little beyond the technique of their own departments. In fact, the school was organized partly because once when two superintendents were wanted, none of the foremen were found fitted for advancement.

NIGHT SCHOOLS.—Mr. John L. Shearer (President of the Ohio Mechanics' Institute) took the view that the night school is not advisable in itself, but is a necessary evil under the modern system of living. It should be for adults only, and not for the young. Nevertheless, it is an important adjunct to educational facilities and a feeder to many business and industrial interests. Mr. Shearer deprecated the tendency to look on trade schools as producers of mechanical engineers and held that their purpose should be for educating men in and for the shops—not for educating them out of the shops. Mr. Louis Rouillion (Director of the School Department of the New York Mechanics Institute), took the opposite view and regarded the night school as an absolute benefit. The boys are eager for their work, enjoy it and it forms an outlet for their energy. He then outlined the character of the organization and the instruction in his own institution. Mr. Charles R. Dooley (President of the Casino Technical Night School at East Pittsburg) described one organization, the work as a technical night school and also the day shop-work and teaching system for training the apprentices of the Westinghouse Electric & Mfg. Co. In the shops, a section is fitted up specially for the instruction of apprentices under the guidance of intelligent foremen.

He pointed out that the manufacturer looked to the engineering colleges for the supply of his engineers and managers, and regarded as equally important the trades school which will adequately train and broaden the interests of his workmen.

At the evening session, Mr. John Golden (President of the United Textile Workers) spoke upon the need of state legislation for technical education, and asserted that the wage-earners and the trades unions encourage the development of such education. Mr. J. D. Burks (Philadelphia Bureau of Municipal Research) expressed the opinion that the practical outcome of the movement (in spite of a general recognition of the need of industrial education) has not been at all commensurate with the energy that has been put into it. The net result so far is seen in 30 public high schools known as manual-training schools, technical high schools and mechanics-art schools. Most of these give from five to nine hours of instruction per week, some even giving as little as four hours and some as much as 12 hours. He considered that the need at the present time is not general discussion as to the need for industrial education (since that has been proved and is recognized), but rather the con-

centration of the energy upon a definite working plan and the carrying of this into effect.

Mrs. Anna G. Spencer (of the Society for Ethical Culture) thought that industrial education was undertaken too often with a view primarily to its commercial side as benefiting the trade and the manufacturer. She pleaded that more consideration should be given to the human side of the problem, in the personal interests of the individual child and the general interests of the community. Prof. E. C. Meyer (of the Department of Political Science, University of Wisconsin) dealt with the industrial education system as developed in Germany. A good part of his remarks, however, dealt with development beyond the real scope of trades schools, such as the technical and commercial universities which are for the training of scientists and investigators rather than for that of skilled artisans. The real purpose of the industrial education movement in this country, as pointed out by other speakers, is the training of artisans and workmen, and incidentally for the development of those who are capable of becoming foremen, superintendents and higher officers.

The morning session of Dec. 4 was devoted to papers on the subject of intermediate industrial schools, whose special purpose is to hold the boys who drop out of the regular public schools on (or before) finishing in the ordinary grades, and to prepare them for the trades schools proper. Some of the papers, however, dealt with schools which are wide of this mark and are really trades schools, taking boys from 13 to 17 years of age. The papers were by Mr. Charles R. Allen, Director of the New Bedford Industrial School; Mr. Wm. H. Elson, Superintendent of Schools at Cleveland; Mr. Edgar S. Barney, Superintendent of the New York Hebrew Technical School for Boys; and Mr. Charles S. Pickett, Principal of the New York Preparatory Trades Schools for Boys.

The most pertinent discussion of the subject, however, was given in an address by Mr. L. D. Harvey, Superintendent of Schools at Menomonie, Wis. He took the position that the trades schools do not meet the conditions or requirements, and instanced the well organized and thoroughly equipped school of Milwaukee, which has only 66 pupils. In his view, the trades school is only a part of the real system of industrial education, and the beginning should be in the public schools, not to teach trades but to fit the pupils to learn trades after they pass from the regular schools. In this way, the intermediate or preliminary training would reach thousands of children who are not reached by the trades school. Mr. Carroll G. Pearse, Superintendent of Schools at Milwaukee, took somewhat the same view. He also emphasized a view expressed by other speakers that the industrial training should be available to all who have capacity for it, and that there ought not to be ground for the complaint voiced by a boy to the effect that "a fellow can't learn a trade unless he's sent to the reform school."

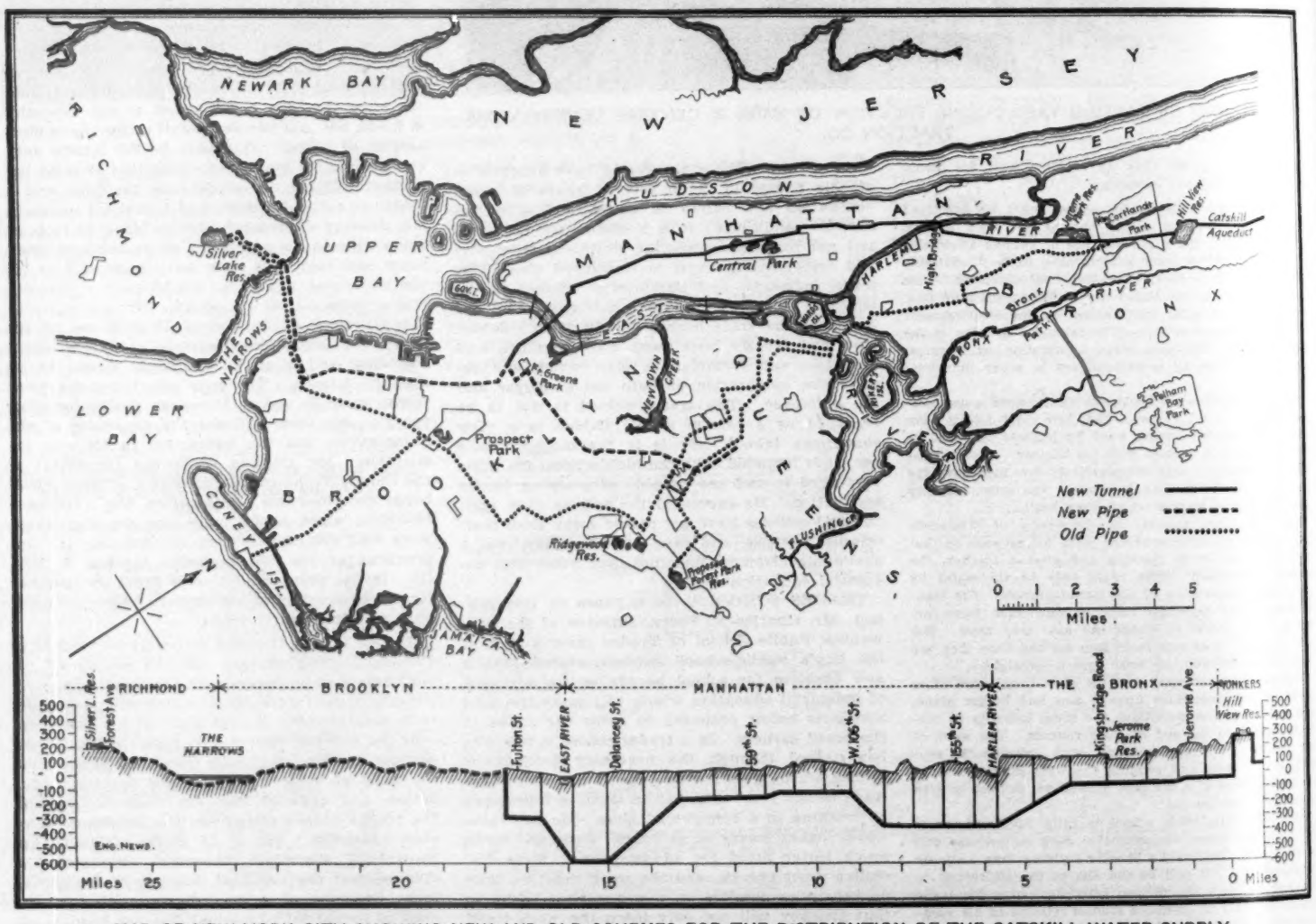
At the business session on the afternoon of Dec. 4, there was some discussion over a report, from a special committee, on classifying the systems of industrial education for the purpose of giving a clear idea of what is meant. It was finally decided not to adopt the report, but to accept a report of progress. Resolutions, proposed by the committee, were adopted, however. These call the attention of the President and Congress to the importance of this matter in its relation to national progress, and urge that adequate appropriations should be made to enable the U. S. Bureau of Education to investigate the ways in which government assistance may be rendered.

Mr. Charles R. Richards, of New York City (Director of Cooper Union), was elected President. Mr. Theodore Roberts was elected Vice-President, and Mr. Frederic B. Pratt (Pratt Institute, Brooklyn, N. Y.), Treasurer. The Secretary had resigned a short time before the meeting, and was not present. Mr. Louis Rouillion, of New York, was elected temporary Secretary, but the permanent appointment is in the hands of the Board of Managers. The reports of the secretary and treasurer showed a membership of nearly 2,000 and a cash balance of about $850.

EXHIBITS.—One of the halls of the Auditorium was filled with an excellent display of the work of 30 industrial and trades schools in 16 cities. These represented the systems of education and the product of the pupils. The exhibits were of a most varied character; from dressmaking to machinery, from wood carving to plumbing, and from soap making and bricklaying to industrial and decorative art.

A Proposed Water-Supply Tunnel Under New York City.

In the plans for taking an additional water supply for New York City from the Catskill Mountain region, the Board of Water Supply has not heretofore published any detailed scheme for the delivery of the water below the equalizing Hill View Reservoir, just north of the northern boundary of the city. The report of 1905, which outlined the proposed system, provided for the distribution of 120,000,000 of the available 500,000,000 gallons per day, to the Boroughs of Richmond and Brooklyn and expressly stated that "the main distributing lines from Hill View Reservoir to the Boroughs of Manhattan, Queens and the Bronx are matters for later consideration." It also stated that "the precise forms, dimensions and locations best adapted for the proposed terminal reservoir of the aqueduct system in Brooklyn and on Staten Island remain as subjects for future study," but, nevertheless, the plan shown in dotted line on the accompanying map was tentatively adopted. This scheme com-



MAP OF NEW YORK CITY SHOWING NEW AND OLD SCHEMES FOR THE DISTRIBUTION OF THE CATSKILL WATER SUPPLY.

prised a series of 48 and 66-in. pipe mains from the Hill View Reservoir through the Bronx, crossing the East River near Ward's Island, thence through Brooklyn and Queens (with a reservoir in the latter place), across the Narrows into Staten Island. From these mains, the Department of Water Supply, which has charge of the water distribution system inside the city limits, was to connect up its pipe system. On account of the remoteness of this reservoir-connecting main from the centers of population of the city, the subsidiary distributing system was necessarily of considerable extent and high cost.

The first proposal has now been abandoned for a more extensive and radically different plan. Under date of Nov. 15, 1909, the Board of Water Supply submitted a report to the Board of Estimate and Apportionment, substituting for the tentative plan noted above, a working scheme which includes a single, low-level pressure tunnel in solid rock, 17½ miles long, from the Hill View Reservoir under a portion of Bronx Borough and Manhattan Island, under the East River just above the Manhattan Bridge to a point in the downtown district of Brooklyn, from which point two pipe mains extend, one through Brooklyn toward Queens and one, following the previously planned route, under the Narrows, not in tunnel but as a sunken pipe line, into the Silver Lake Reservoir on Staten Island. This system will carry a supply of 280 million gallons daily to Manhattan, 100 millions to Brooklyn, 20 million to Richmond and leave 100 million available for Queens or elsewhere as needed.

The route and profile are shown on the accompanying map. The invert grade of the tunnel at the reservoir is to be at elevation -20, and from there south it will drop on a slight grade to the Harlem River, where a sharp drop to about elevation -360 is required by the soft nature of the rock. Under Manhattan, the geological formation allows a rise to a maximum of elevation -140, and dropping near Delancey St., where a bad pocket of rock was found, to the lowest elevation on the route, viz., -600. Under the East River the elevation is to be about -450, and thence the tunnel continues to the pipe main juncture at elevation -300. From there the pipe lines are as shown, all elevations, of course, being only approximate.

The tunnel through the Bronx and Manhattan is the most important feature of the design. This tunnel will be about 16½ ft. in diameter at the upper part and 11 ft. where it goes under the East River. It is to be through the gneiss, schist and limestone formations underlying the city, the position and condition of which have been carefully investigated in a very thorough set of borings along the proposed line. In form, the tunnel is to be after the same design that the Board of Water Supply is using on its aqueducts up-state, that is, a concrete-lined circular bore through the solid rock, far enough below the surface to ensure sufficient strength from the rock cover. Though the depth below the surface is greater in places on the city tunnels than in the upper aqueduct, the drop in hydraulic gradient makes the maximum pressure in the city lower than the maximum pressures in the tunnels already under construction.

Throughout the entire length the tunnel is to be under city property, with only a few minor exceptions. Construction is to be carried on from 23 construction shafts, spaced about every 4,000 ft. along the line, and in nearly every instance in some park space, where the surface work will not interfere with business or traffic. These construction shafts will be subsequently used for the uptake pipes to the minor distribution system, by placing in them, encased in concrete and concrete-lined, vertical pipes connecting with the street mains. These uptake pipes will be controlled from the surface by specially-designed valves at the juncture of the main tunnel and the vertical riser.

It is claimed that very real benefits will result from this new design. The Board of Water Supply, by statute, is allowed $162,000,000 to complete the new Catskill aqueduct, and for that sum is required only to bring the water to distribution points, from which the Department of Water Supply could conveniently pipe it to the city services. Under the old scheme, these centers were the Hill View Reservoir, for Manhattan and the Bronx, a proposed reservoir in Forest Park in Brooklyn and a proposed reservoir on Staten Island. From these points all distribution costs were to fall on the Department of Water Supply. Under the new scheme, the aqueduct mains are brought much nearer the centers of service, so that the connecting lines will be much shorter and hence much cheaper. At the same time the cost of the system will not be any greater than with the pipe lines as first proposed. Thus, although the Board of Water Supply will be able to construct this system inside the city without exceeding its appropriation of $162,000,000, the Department of Water Supply will be saved about 50% on the original cost of its connections, in addition to the consequent saving in interest and sinking fund charges. This is the first saving in cost. The second is in maintenance, for it is anticipated that the up-keep of the single pressure tunnel will be much less than that of the thirty 48-in. or sixteen 66-in. pipes it will replace; in fact the maintenance of the tunnel should be practically nil.

By delivering water through the tunnel, an additional pressure of 100 ft. is gained in the lower part of Manhattan and in Brooklyn and in Richmond, so that water can be delivered in Brooklyn at about elevation 260 above sea-level and in Richmond at elevation 225. In New York at present there is now about $400,000 annually expended in public pumping and about $1,500,000 annually in private pumping, nearly all of which it is thought can be saved by the high pressure service through the tunnel.

In construction, the tunnel has the advantage of being well under ground where, during actual work and in operation, it will not interfere with the numerous other surface and subsurface subways, pipe-lines and foundations now in place or in the future to be placed on Manhattan Island. Finally, the interconnection of the services in the various boroughs is closer under the proposed system, so that there is better provision for such emergencies as large fires in one section. It is proposed to build first the connections under the East River and the Narrows, and to join the present Croton service to the adjacent boroughs to be used for emergencies until the completion of the Catskill project.

A public hearing was held on the proposition on Dec. 3, and it is expected that the Board of Estimate and Apportionment will soon take some action on the scheme. The members of the Board of Water Supply are Messrs. John A. Bensel, Charles N. Chadwick and Charles A. Shaw, and the Chief Engineer of the Board is Mr. J. Waldo Smith.

The Construction of a Four-track Truss Bridge with Solid Floor; Chicago & Oak Park Elevated Ry.

The elevated approach of the Chicago & Northwestern Ry. to its new passenger terminal station in Chicago crosses the line of the Chicago & Oak Park Elevated Ry. on Lake St., and this interference necessitated not only the raising of the elevated railway to give sufficient clearance for trains on the new tracks below, but also the construction of a bridge spanning these tracks. The raising of the elevated railway structure was described in our issue of Oct. 29, 1908. At the intersection of the two lines, the old deck

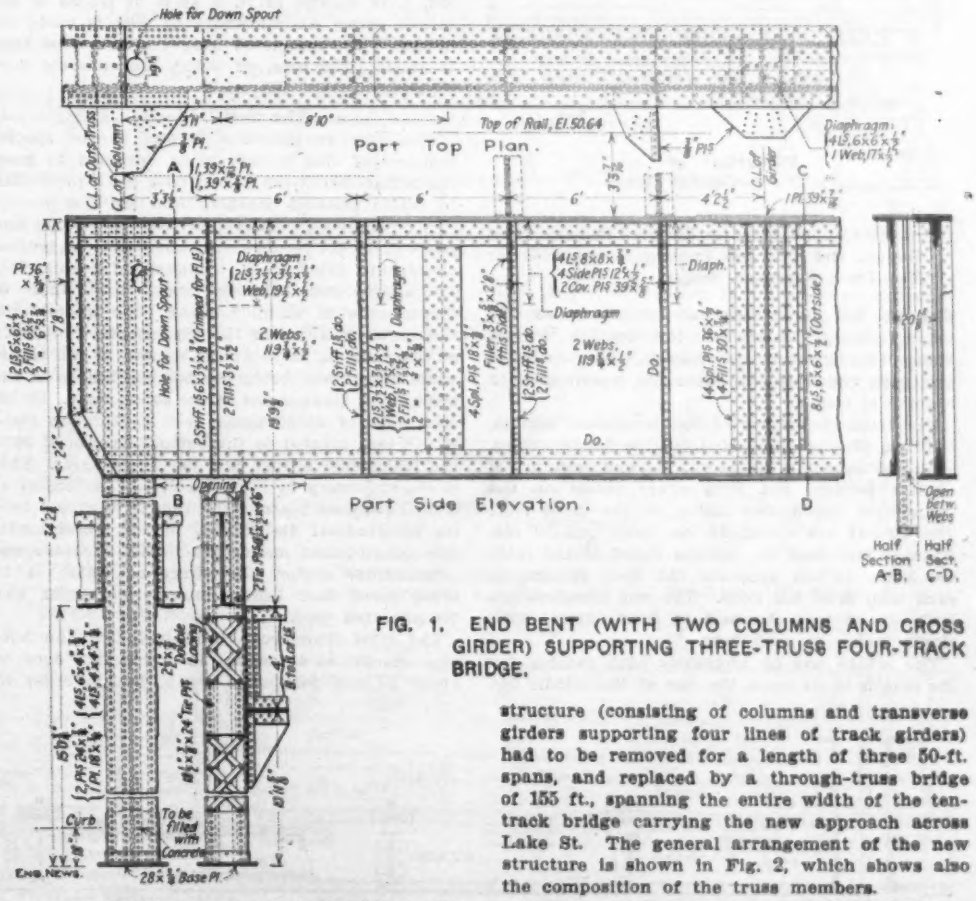


FIG. 1. END BENT (WITH TWO COLUMNS AND CROSS GIRDER) SUPPORTING THREE-TRUSS FOUR-TRACK BRIDGE.

structure (consisting of columns and transverse girders supporting four lines of track girders) had to be removed for a length of three 50-ft. spans, and replaced by a through-truss bridge of 155 ft., spanning the entire width of the ten-track bridge carrying the new approach across Lake St. The general arrangement of the new structure is shown in Fig. 2, which shows also the composition of the truss members.

The elevated railway has transverse girders long enough to carry four tracks (though it has track stringers for only the two middle tracks at present), and it was required that the new bridge should provide for four tracks. For this reason a three-truss bridge was adopted. It has riveted trusses of 155 ft. span between shoe pins; the trusses are 32 ft. deep and are spaced 26 ft. 6 ins. c. to c. of chords. Each end of the bridge is supported by a bent composed of two posts (at the curb lines) and a massive double-web transverse plate girder which embraces the columns. Each of these bents is braced by longitudinal struts or bracing trusses fitted between the columns of the bridge bent and those of the next adjacent bent of the elevated railway structure. The rear web of the girder has the attachments for the track stringers of the girder spans.

These supporting bents are necessarily of very massive construction (as shown in Fig. 1), the base of each of the columns carrying 340 tons

of dead load and 196 tons of live load. The columns are about 20 × 24¼ ins. in section. They are built up of two side plates, a middle web plate and eight angles, with double lacing across the outer angles. The girders have webs 10 ft. deep, one on each side of the column (which extends to the top of the girder), with top and bottom cover plates. The bottom cover plates do not extend the full length between the columns, so that at each end there is an opening (X, Fig. 1) giving access to the interior of the girder for inspection and painting. Diaphragms are fitted between the webs, but do not extend to the bottom of the girder. On top of each girder are bearing plates for the shoes of the three trusses, those for the outside trusses being directly over the columns. The shoes at the east end rest on expansion bearings with segmental rollers.

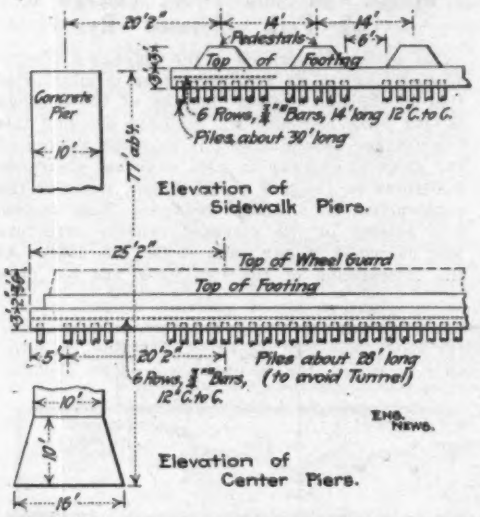


Fig. 5. Pier Foundations for Elevated Railway Truss Bridge, and Pile and Footing Foundations for Ten-Track Approach Bridge.

The truss chords are of double-channel section, built up of web plates and outside flange angles, with double lacing, as shown. The end posts are of similar section, but with cover plates on the outer side and double lacing on the inner side. The chords are about 24 ins. deep and 22 ins. wide, except that the bottom chord of the middle truss (which supports the floor system on each side) is 36 ins. deep. The web members are built up of two channels or four angles, with single lacing in each case.

The bridge has an unusually high camber for the length of its span, the rise at the middle being 2¾ ins., as shown by the diagram in Fig. 2. The reason for this is that the bridge is at a summit of grades, which are thus connected by a vertical curve over the bridge. The arrangement provides also for free drainage to the ends, and across each end of the floor is an 8-in. gutter in the concrete, connecting with 5-in. downspouts set inside the columns. Of the total camber, 2 ins. is for live load and drainage and ¾-in. for dead load deflection. The chord sections were made straight between panel joints, and when riveted up at these points, they were forced up by jacks at the mid-panel points to connect with the verticals.

The plates and shapes are of medium structural steel (conforming to the C. & N. W. Ry. specifications), with steel shop rivets and iron field rivets. The shoes for the trusses and columns are of cast-steel. The rivets are mainly ⅞-in. diameter in 15/16-in. holes; ¾-in. rivets in 13/16-in. holes are used in the flanges of 12-in. channels and I-beams and in 3-in. legs of angles. All field connections for truss members were reamed to iron templates. The unit stresses are as follows: tension, 11,000 lbs. per sq. in.; bearing, 15,000 lbs. for shop and 12,000 lbs. for field rivets; shear, 7,500 and 6,000 lbs. for shop and field rivets, 9,000 lbs. for web plates; compression (L = length of member in inches, R = radius of gyration)

$$P = \frac{11{,}000}{1 + \frac{L^2}{36000\,R^2}}$$

The assumed live load differs, of course, from that used for ordinary railway bridges. It consists of a train of 44-ton motor cars on each track, with 11 tons on each axle. The trucks have 6-ft. wheel-base, with a spacing of 32 ft. 4 ins. c. to c., and 14 ft. c. to c. of trucks of adjacent cars. An allowance of 20% is made for impact. The completed weight of the truss span is about 1,225 tons, of which the concrete floor represents about 708 tons.

The Solid Floor.

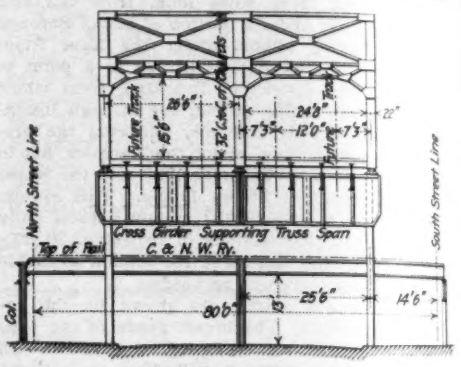
The floor construction is one of the special features of this bridge, being designed to meet the requirements for a solid floor (as a protection to trains passing beneath) and for the protection of the steel against the effect of smoke and gases from the locomotives. Between the bottom chords are fitted 15-in. transverse I-beams, 18¼ ins. apart, and between these are lines of diaphragms of 12-in. I-beams, one under each rail. The bottoms of the diaphragms are coped at the ends, so as to fit the flanges of the transverse beams and bring the bottom flanges of the beams and diaphragms in the same plane. Under each line of diaphragms is a continuous plate ⅝ × 8 ins., riveted to the bottom flanges of both the transverse beams and the diaphragms. This is shown clearly in Figs. 3 and 4. The object of this continuous plate connection is to give a better longitudinal distribution of the wheel loads. The construction makes practically a continuous longitudinal girder, the effect of which is to bring more floor beams into action under any concentrated load.

The steel framework (and including the bottom chords) is embedded in a concrete floor of about 24 ins. maximum depth, but in order to reduce the weight, cells or hollow spaces are cored between the I-beams and diaphragms. These were made by wooden box forms, which remain in place, being entirely built into the floor. A drainage hole is cored in the bottom of each cell; this was formed by a square taper plug set between the box and the outer form (and in line with a hole in the bottom of the box), so that it could be pulled out when the concrete had set and the outer form was removed. A strip of expanded metal is wrapped around the bottom flange of each 15-in. and 12-in. I-beam, and flat sheets of expanded metal rest upon these flanges.

The concrete (or rather grout) was composed of 1 part cement and 3 parts of torpedo sand obtained by screening the gravel used in ordinary concrete work. It was mixed wet and well rammed in order to get a dense and waterproof concrete and to fill all interstices and vertical corners. It was to ensure this close filling that no stone (or gravel) was used. The upper surface of the concrete is shaped to form drainage planes, with a minimum thickness of 1½ ins. over the flanges of the 15-in. I-beams. No waterproofing composition has been applied to the surface of the concrete floor.

Track Construction.

The track construction also is of a special design (Fig. 4), and presents some novel and interesting features in the method of attaching the rails to the floor system. The rails are of the 80-lb. Am. Soc. C. E. section, and each is laid in a trough formed by a 12-in. channel riveted to the 15-in. I-beams of the floor. At the location of each fastening, four pockets were cored in the concrete under the steel channels by means of pieces of 3-in. gas pipe, each with a bottom plate held in place by an erection bolt tapped into it, as shown by the detail in Fig. 4. These bolts were set in rectangular slotted holes in the channels, the greater length of the slot being parallel with the rail. When the concrete had set, the tap bolts were removed. The tee-head of a special bolt (A) was then inserted, and turned to bring its head crosswise of the slot, thus holding it in position.



Cross Section.

Fig. 2.

On each side of the rail is placed a casting (B), having its face shaped to fit the flange and web of the rail, while the back has a groove to receive a horizontal steel wedge or key (C), driven between the casting and the side of the channel. These wedges enable the rails to be adjusted accurately to gage and position. In each casting are two slotted holes, at right angles to the rail; these fit over the tee-head bolts and allow of lateral movement in the adjustment of the fastenings, but prevent the bolts from turning, as the square neck of the bolt fits into this hole.

The castings being set in position over the bolts and adjusted, flat washers are put on and the nuts screwed down to a tight fit. The fastenings are left uncovered at present, to enable them to be kept under observation, but they show no signs of working loose under the constant traffic. Eventually the trough will be filled with asphalt, covering the fastenings, as shown. Should a car be derailed the wheels would presumably cut into this filling so that the sides of the channels would act as guard rails. No other form of guard rail is provided across the bridge.

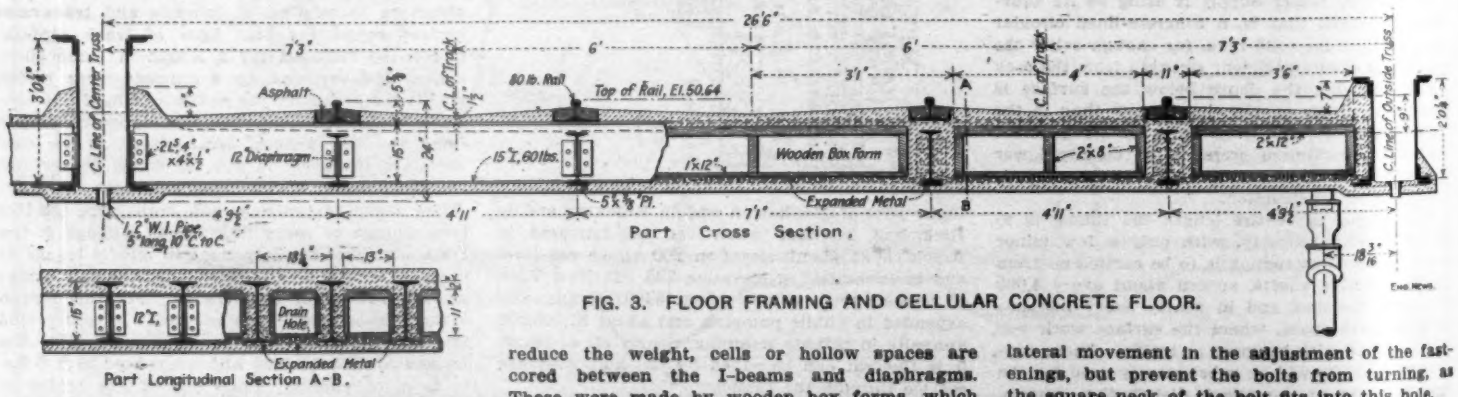


FIG. 3. FLOOR FRAMING AND CELLULAR CONCRETE FLOOR.

Bridge of the C. & N. W. Ry.

The structure of the Chicago & Northwestern Ry. approach across Lake St. (and under the truss bridge) has a self-supporting floor of deep rectangular troughs, as shown by Fig. 1. There are four spans, the ends resting on five lines of transverse plate girders supported by rows of steel columns at the building lines, the curb lines and the middle of the street. These trough-floor spans are filled with concrete, waterproofed with asphalt mastic and covered with broken stone ballast. The clear headway from the street to the railway bridge is 13½ ft. The clear headway from the railway tracks to the bottom of the floor of the elevated bridge is 16.89 ft.

Foundations.

Each of the columns of the end bents supporting the truss bridge rests upon a 10-ft. cylindrical concrete pier, the top of which is 3 ft. 6 ins. below the street. The shafts for these piers (which are colloquially known as "caissons") were sunk in the way now generally adopted for deep foundations in the Chicago clay; the excavation is made by hand, and is lined by vertical tongued and grooved staves braced by steel rings on the inside of the shaft.

The average depth is about 70 ft. from the curb line to the base of the pier, and the bottom 10 ft. is belled out as a conical chamber to give a diameter of 16 ft. at the base (with a bearing area of 201 sq. ft.). The loading on the base of each pier is about as follows: dead load from the column, 340 tons; dead load from the pier, 400 tons; live load from the column, 196 tons; total, 936 tons. Thus the load is about 4.7 tons per sq. ft., of which 3.7 tons is due to dead load and 1 ton to live load.

The three lines of columns which carry the bridge of the Chicago & Northwestern Ry. approach are supported on concrete footing walls 3 ft. deep and 6 ft. wide. These rest on piles about 30 ft. long, the heads of which are embedded in the concrete, and just above the level of the pile heads the walls are reinforced by steel bars. The two walls at the curb lines are surmounted by concrete pedestals for the columns, and for these walls the load per pile is 18 tons. The wall in the middle of the street carries a continuous footing 2 ft. deep, and for this wall the load per pile is 16 tons. The general character of the foundations is shown in Fig. 5.

Erection Methods and Falsework.

The erection of the structure was complicated by the existence of the old structure, and by the necessity of providing for uninterrupted traffic on the elevated railway, besides caring for street car and general traffic in a busy street. The sidewalks were obstructed by the falsework. The street was closed to traffic while the piles were being driven for the footing wall in the middle of the street, and during the raising of the heavy cross girders of the two end bents. In driving the piles noted above, special arrangements had to be made, as the elevated railway structure prevented pulling a pile driver in place. A pair of false leads was used, suspended from a trolley made to run on the bottom flanges of the track stringers of the structure, and in the leads was set a steam pile hammer. A trench was excavated to such depth as to allow the piles to be set under this hammer.

The first step was to erect a double-deck falsework for the entire length of the bridge, and wide enough to carry the tracks of the elevated railway outside of the lines of the new trusses. These temporary tracks were about 77 ft. c. to c. The falsework had bents supported on the sidewalk and at the middle of the street, and the part of the street left open for traffic was covered with a plank roof at the lower deck as a protection against falling tools or material. The sides of the falsework were also sheathed with planking for a similar reason, so that the street cars and vehicles passed through a sort of twin tunnel. The street car tracks were laid temporarily near the curb line of the street. At each end of this falsework, trestling was erected to carry the elevated railway track diverging from the old structure to the temporary tracks.

The general character of the construction of

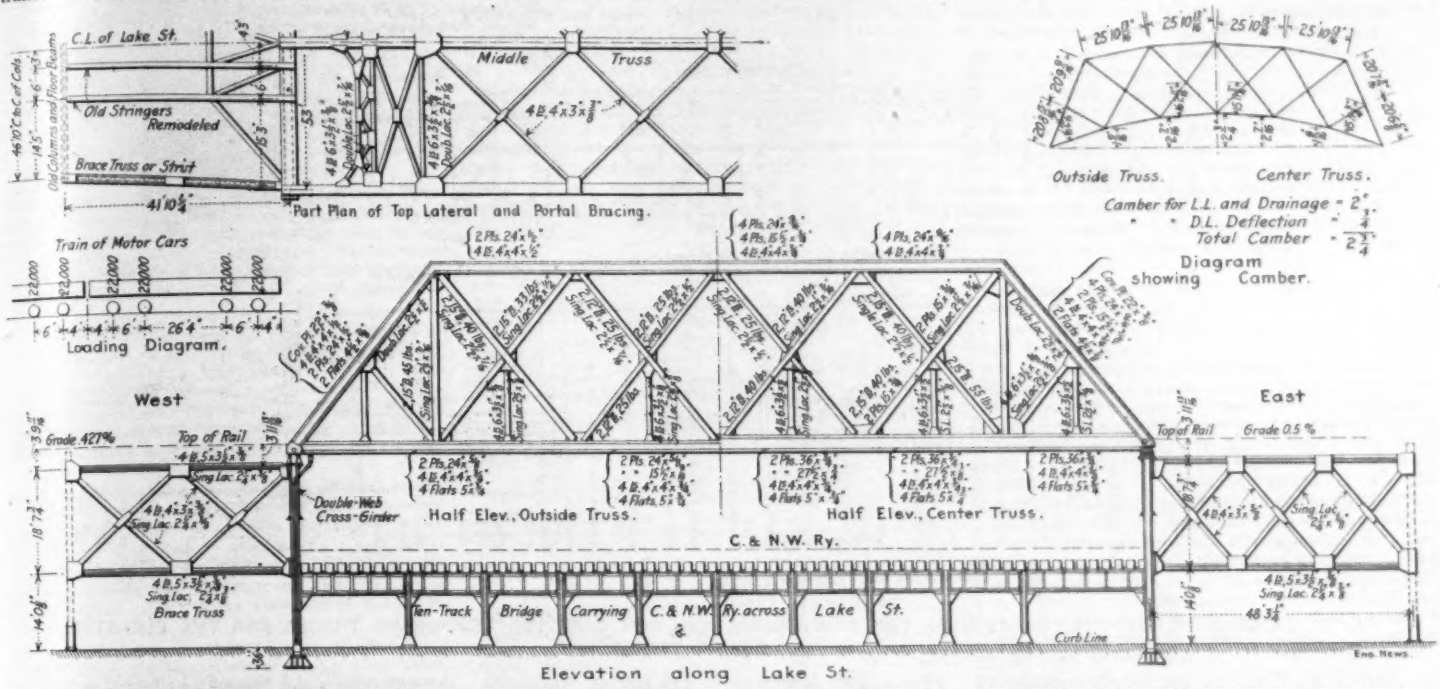


FIG. 2. FOUR-TRACK SOLID-FLOOR TRUSS BRIDGE BUILT TO CARRY THE CHICAGO & OAK PARK ELEVATED RY. OVER THE TEN-TRACK BRIDGE CARRYING THE CHICAGO & NORTHWESTERN RY. TERMINAL APPROACH ACROSS LAKE ST.

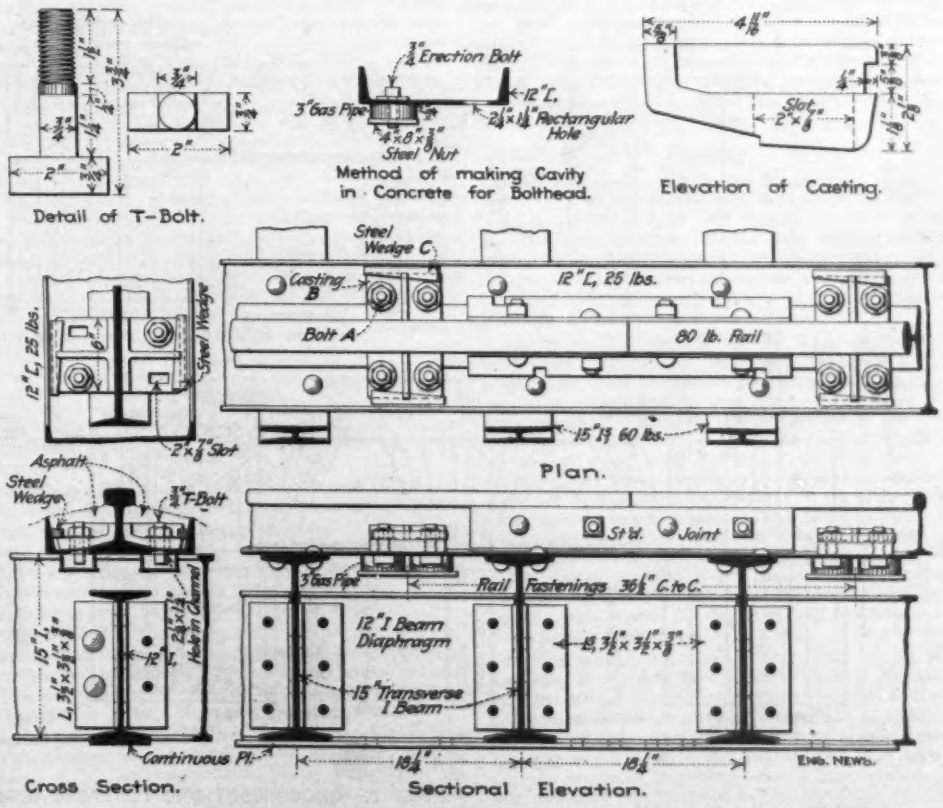


FIG. 4. TRACK CONSTRUCTION AND RAIL FASTENINGS ON SOLID-FLOOR BRIDGE.

the falsework, with the arrangement of the tracks is shown in Figs. 6 and 7. For bents Nos. 1 to 18, the lower story of the falsework was erected complete. Posts (1) to (7) were then erected, with their caps (A) (A) and the bracing. The temporary tracks were then laid and traffic diverted as soon as the connecting trestles at each end were completed.

The old structure had been previously raised to the new grade, by splicing extensions on the bottom of the columns (as described in our issue of Oct. 29, 1908). As soon as traffic was diverted, the part of the structure to be removed was lowered about 2 ft. (so as to clear the lowest part of the new work) by cutting out the splices. This is shown by the dotted lines (X) (X) in Fig. 6. Thus the old structure served to carry tracks for material cars and for the contractors' derrick car which did all the erection.

All material for the truss was delivered to the elevated railway on cars at Ridgeland, where the tracks are on the surface and a connecting spur was built to the parallel tracks of the Chicago & Northwestern Ry. By arrangement with the traffic officers of the elevated railway, the cars were hauled downtown to the site at convenient times of the day when traffic was light, usually between 10 a. m. and 2.30 p. m.

The columns and 45-ton cross girders of the two-end bents were hauled on special wagons to the street. The two columns of each bent were erected temporarily outside of their proper positions, to allow the cross girder to be set in position across the street, the street being closed to traffic for about a week. There was no room to erect hoisting machinery, and the method employed was to raise the girders by jacks and build up blocking beneath them, in the same manner as the elevated railway had been raised. When the girders were at the proper elevation the columns were moved laterally into place (between the girder webs); and the connections were riveted up. The vertical end cover plates of the girders were then put in place, closing the openings through which the columns had been moved into position.

The work was commenced on Dec. 24, 1908, and the elevated railway traffic was diverted to the temporary tracks on Jan. 16, 1909. The bridge was completed on April 22, and traffic was resumed on the permanent tracks on May 2, 1909. By June 15, all the falsework had been removed and the street cleared.

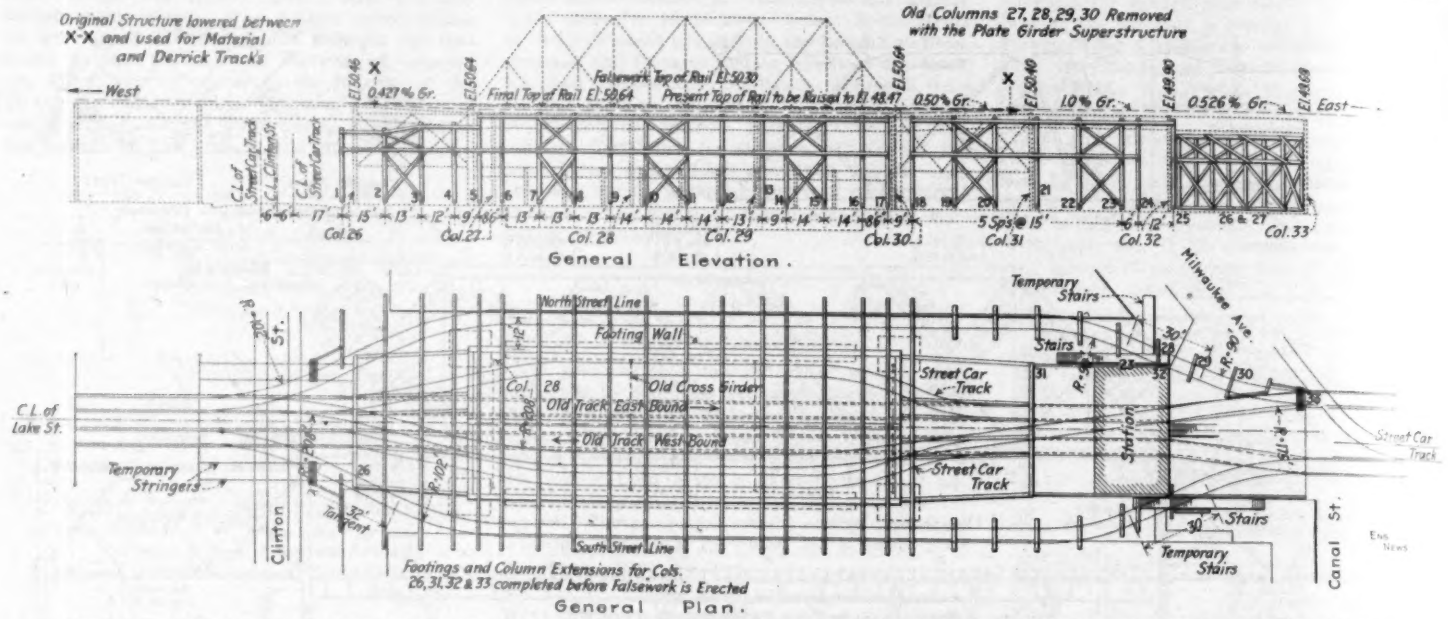


FIG. 6. FALSEWORK FOR THE ERECTION OF THE NEW BRIDGE AND FOR CARRYING TEMPORARY TRACKS FOR THE ELEVATED RAILWAY DURING THE WORK.

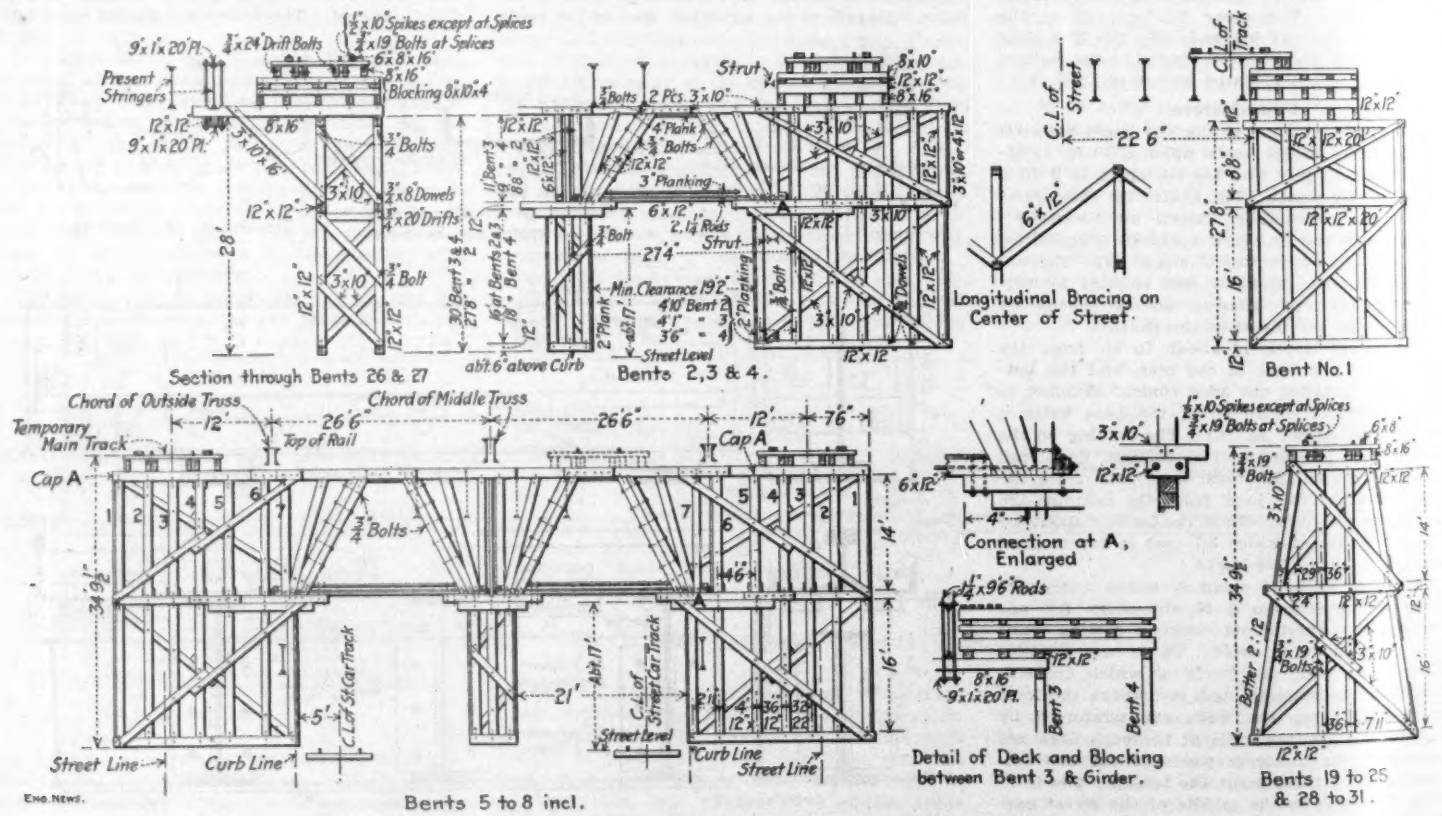


FIG. 7. CROSS SECTIONS OF FALSEWORK.

Engineers and Contractors.

All this work was done at the expense of the Chicago & Northwestern Ry. and in accordance with plans prepared by its engineers, subject to

the approval of the elevated railway company. Mr. E. C. Carter, M. Am. Soc. C. E., is Chief Engineer, and the work was under the direction of Mr. W. C. Armstrong, M. Am. Soc. C. E., Terminal Engineer, who is in charge of the construction of the new terminals. The plans were subject to the approval of Mr. C. M. Mock, Chief Engineer of the Chicago & Oak Park Elevated Ry.

The steel work was built by the Pennsylvania Steel Co. The construction of the foundations and the erection of the superstructure was done by George W. Jackson (Incorporated), Chicago. Mr. I. J. Crowley was General Superintendent in direct charge of the work for the contractor.

A BOILER EXPLOSION in the basement of a six-story building in Kansas City, Mo., Dec. 6, wrecked the two lower floors of the building and caused the death of two men. Four other persons were injured. The wrecked portion of the building had been vacated for remodeling previously to the accident.

A NITROGLYCERINE MAGAZINE exploded near Cameron, W. Va., Dec. 1, and damaged a number of dwelling houses. One man was killed. He had gone to the magazine to procure some of the explosive for shooting an oil well and he was loading it onto his wagon when the explosion took place. The magazine was the property of the Marietta Torpedo Co.

AN EXPLOSION AT A GAS-RETORT-HOUSE on the Elbe River front at Hamburg, Germany, Dec. 7, wrecked the new 200,000-cubic meter gasometer and caused an extensive fire. The accident is attributed to a leak in the new gasometer. A large number of workmen were engaged in rebuilding and enlarging the plant and ten of them were killed. Forty others were injured and 17 are missing.

A FIRE IN A COPPER MINE at Copper Hill, Tenn., Nov. 30, rendered the main shaft impassable and eight men were imprisoned. Oxygen helmets were brought from the U. S. Geological Survey's rescue station at Knoxville and an unsuccessful effort was made to enter the mine. Reports state that the rescue party had trouble with the helmets in attempting to go through the difficult passages of the mine. The imprisoned men were rescued Dec. 1 by an unhelmeted party. They were found at a distance of 140 ft. from the shaft and had built a partition to protect themselves from the smoke and gas of the fire. The mine is owned by the Tennessee Copper Co.

THE U. S. CRUISER "YANKEE" was raised to the surface Dec. 7 from where she had sunk in 40 ft. of water in Buzzard's Bay, but sank again after floating only a few minutes. The raising of the cruiser was accomplished by the Arbuckle Wrecking Co. by means of compressed air. The "Yankee" ran aground on Spindle Rock at the western entrance to Buzzard's Bay, Sept. 23, 1908. She was raised on the afternoon of Dec. 4, 1908, by the Arbuckle Wrecking Co., but sank twelve hours later near Penikese Island while being towed to New Bedford, Mass.

THE PANAMA CANAL WORK was more or less impeded during the week ending Nov. 20, by high water in the Chagres River. An extraordinary rainfall during the week raised all the streams on the Isthmus to a height that has not been reached before since 1906. During the first 20 days in November, the rainfall at Gatun was 25.87 ins., and at Porto Bello, on the Atlantic Coast, it was 32.81 ins. During the same time, at stations in the Upper Chagres watershed rainfalls of 23 to 24 ins. were recorded. On Nov. 19, the Chagres at Gamboa reached a height of 72.6 ft. above sea level. The low-water mark at this point is 46 ft. The dike at the entrance to the Culebra Cut, which shuts off the Chagres at high water from overflowing into it, is at 71 ft. above sea level. The water came within a foot of the top of the dike. In the swamps along the valley of the Chagres between Gamboa and Gatun, the tracks of the Panama R. R. were under water for a long distance. At the Black Swamp the tracks were 4 ft. under water on Nov. 20, and traffic over the railways was interrupted for two days. At Gatun the construction of the dam has turned the entire current of the Chagres through the west diversion, two of the channels through which flood water formerly escaped now being closed. As a result, the water reached the highest point ever recorded, or 21½ ft. above sea level, at the gaging station. To give some relief to the flood, the dike back of the spillway excavation was opened and the flood waters were allowed to flow through the spillway. At Mindi the deep cut in which steam shovels are at work was filled with water up to sea level. The concrete-laying on the Gatun locks was not much interfered with, but at the Pacific locks the flooding of the lock pits caused some delay. Interference with the work was caused, however, quite as much by the refusal of the laborers to work in a heavy storm, as by the flooding out of machinery. Notwithstanding all difficulties, the excavation record for the week, in the Culebra Cut, did not fall below 70% of the normal amount.

A COURSE IN OBSERVATION OF PANAMA CANAL work, according to the "Canal Record," is to be prepared for the men assigned to the Corps of Engineers from the class graduated at West Point in 1909. Lieut.-Col. D. D. Gaillard, Maj. Chester Harding and Maj. J. P. Jervey have been designated as a board to prepare a program to be carried out by the new engineer lieutenants. The course will extend over five months' of observation and instruction, and will include practical observation of work in meteorology, river hydraulics, railway location and lock plans and machinery. The young officers are expected to reach the Isthmus about Dec. 10 and will be quartered along the line of the canal.

ACCIDENTS IN NEW YORK CITY.—The Public Service Commission of New York (First District) has issued the following summary of accidents which occurred in October, 1907, October, 1908, and October, 1909, on the railways within its jurisdiction (New York City):

	1907.	1908.	1909.
Car collisions	221	97	123
Persons and vehicles struck by cars	1,145	882	1,134
Boarding	510	533	561
Alighting	593	681	641
Contact electricity	...	33	27
Other accidents	2,397	2,442	1,961
Total accidents	4,866	4,668	4,447
Injuries:			
Passengers		1,715	1,742
Not passengers		738	548
Employees		500	440
Total injuries		2,953	2,730
Serious (included in above):			
Killed	47	47	25
Fractured skulls	15	15	8
Amputated limbs	9	10	3
Broken limbs	40	36	38
Other serious	80	60	138
Total serious injuries	191	168	212

AN INTERNATIONAL CONGRESS OF RADIOLOGY and Electricity is announced to take place at Brussels, Belgium, on Sept. 6, 7 and 8, 1910. There will be three sections. In the first, general questions of terminology and methods of measurement in radio-activity and subjects connected with ions, electrons, and corpuscles will be dealt with. The second section will deal respectively with fundamental theories of electricity, study of radiations, radio-activity, atomic theory, and cosmical phenomena (including atmospheric electricity and atmospheric radio-activity.) The third section will be biological, and will be devoted to consideration of the effects of radiations on living organisms. Sub-sections will deal with purely biological questions as well as with the use of various radiations for medical purposes, both for diagnosis and therapeutics. Committees have been formed in the various countries which will take part in the congress. Communications should be addressed to Professor Rutherford at the University of Manchester, Manchester, England, but any one wishing to become a member of the congress should communicate with the general secretary, Dr. J. Daniel, 1, Rue de la Prévôté, Brussels. Communications relating to the biological and medical section should be sent to Dr. W. Deane Butcher, Holyrood, Ealing, London, W.

Personals.

Mr. Earle J. Banta, M. Am. Soc. M. E., has become Chief Engineer of the Cincinnati Equipment Co., Cincinnati, Ohio.

Mr. George W. Tonson has been appointed to succeed Mr. Frank I. Consaul as Chief City Engineer of Toledo, Ohio, effective Jan. 1.

Mr. N. S. Meldrum has become President of the Seaboard Air Line Ry. Mr. C. H. Hicks has been made Vice-President and General Manager and Mr. L. G. Haines has been made Assistant to the President.

Mr. Paul M. Chamberlain, M. Am. Soc. M. E., formerly Chief Engineer of the Underfeed Stoker Co. and Professor of Mechanical Engineering at Lewis Institute (Chicago), has opened an office as a consulting mechanical engineer at 1522 Marquette Building, Chicago.

Mr. Geo. E. Ellis, M. Am. Soc. C. E., has become Vice-President of the Hayes Track Appliance Co., Geneva, N. Y. He was formerly Signal Engineer of the Rock Island Ry. system and more recently has been Manager of Installation for the Federal Signal Co. at Albany, N. Y.

Mr. Paul M. Chamberlain, M. Am. Soc. M. E., has opened an engineering office at 1522 Marquette Bldg., Chicago, Ill. Mr. Chamberlain is a graduate of the Michigan Agricultural College, class of 1898, and of Cornell University, class of 1900. For the past 2½ years he has been Chief Engineer of the Underfeed Stoker Co. of America.

Mr. Henry U. Mudge has become President of the Chicago, Rock Island & Pacific Ry. Mr. Mudge began his career as a water carrier for a section gang on the Atchison, Topeka & Santa Fe Ry. in 1872. He remained in the service of the Santa Fe until 1905, rising meanwhile to the position of General Manager. He left the Santa Fe in May, 1905, to become Second Vice-President of the Chicago, Rock Island & Pacific.

Mr. H. K. Barrows, M. Am. Soc. C. E., has been appointed Associate Professor of hydraulic engineering at the Massachusetts Institute of Technology, Boston, Mass., to succeed Professor Wm. E. Mott, M. Am. Soc. C. E., who resigned to become Professor of civil engineering at the Carnegie Technical Schools, Pittsburg, Pa. Mr. Barrows was for several years District Engineer of the water resources branch of the U. S. Geological Survey, covering work in New York and New England. Since 1907 he has been engaged in practice and consultation as a sanitary and hydraulic engineer at Boston.

Mr. James Lemon, M. Inst. C. E., has been recently knighted by King Edward VII. of England. Mr. Lemon was an assistant to Sir Joseph Bazalgette during the design and construction of the London main sewerage system and the Thames Embankment. He became Borough Engineer and Surveyor at Southampton in 1866, remaining in this position for twelve years. During this period he took an active part in the founding of the Incorporated Association of Municipal and County Engineers. He resigned as Borough Engineer of Southampton in 1878, when he won a premium of $750 for the best scheme for the sewerage and sewage disposal of the City of Winchester and was appointed Engineer in charge of that work. He then went into private practice as a consulting sanitary engineer. He became interested in 1882 in the question of pollution of the water-supply of Southampton and, in the following year, entered the council as a representative of the largest ward in that borough in order to be in a position to obtain action in the matter by the civil authorities. As a result, a new water-supply, which is still one of the best in England, was obtained.

In 1889 Mr. Lemon made an offer of partnership to his principal assistant, Mr. J. H. Blizard, Assoc. M. Inst. C. E., and their subsequent practice has been carried on under the firm name of Lemon & Blizard. Mr. Lemon was elected Mayor of Southampton in 1891 and was re-elected in the following year. During his term of office he was instrumental in securing the transfer of the American Line steamship docks from Liverpool to Southampton and brought about the annexation of Shirley, Freemantle and Bitterne Park to the Borough of Southampton. This annexation was decided upon by Mr. Lemon as a necessary preliminary to the successful municipal ownership of Southampton's street railway and electric lighting system, which he later secured. He retired from public life in 1900.

Obituary.

A. E. Dresser, Manager of the Syracuse office of the Fort Wayne Electric Works, died Nov. 28 and was buried at Ithaca, N. Y., Nov. 30. Mr. Dresser was 46 years old and had been employed by the Fort Wayne Electric Works for the past ten years. He was previously with the Fort Wayne Electric Corporation and was formerly connected with the General Electric Co. and the Thompson-Houston Co.

John Caldwell, Treasurer of the Westinghouse Airbrake Co., at Wilmerding, Pa., whose death was briefly noted in our issue of Nov. 25, was born nearly 70 years ago in a village on the west coast of Ireland. His early education was received from his father, who was a Presbyterian minister. He came to the United States at the age of 16 years and joined an older sister at Pittsburg, Pa., where he was employed as an errand boy and clerk in a grocery. He enlisted at the time of the Civil War in the 61st Pennsylvania regiment and, at the termination of the war, had risen to the rank of Second Lieutenant. He was one of the first employees of Mr. George Westinghouse in the business of airbrake manufacture, being at first employed as a bookkeeper. As the company grew, he was made head bookkeeper and later became Treasurer.

William Metcalf, Past-President, Am. Soc. C. E., and Am. Inst. M. E., died Dec. 5 at his home in Pittsburg, Pa. Mr. Metcalf was born at Pittsburg in 1838 and was a graduate of the Rensselaer Polytechnic Institute in the class of 1858. After graduating, he was employed as a draftsman by the Fort Pitt Foundry Co., at Pittsburg, and one year later he became General Superintendent of that company. He remained in this position until 1865, and, during this time, several thousand heavy guns and projectiles were made under his supervision for the U. S. Government.

In 1865, Mr. Metcalf became a member of the firm of Charles Knap, Nephews, which leased and operated the Fort Pitt foundry until late in 1867. In 1868 he joined the firm of Miller, Barr & Parkin, proprietors of the

Crescent Steel Works at Pittsburg, and he has since remained with this company, which was incorporated as the Crescent Steel Co. in 1880 and was later taken into the Braeburn Steel Co., of Pittsburg. During his 25 years' connection with the manufacture of steel, he became a recognized authority on the subject and presented a number of papers on the metallurgy of steel and related topics before the national engineering societies. Mr. Metcalf was President of the American Institute of Mining Engineers in 1881, President of the American Society of Civil Engineers in 1893, and was twice President of the Engineering Society of Western Pennsylvania. He was also a member of the American Society of Mechanical Engineers and the British Institution of Civil Engineers. A portrait of Mr. Metcalf and a fuller account of his career was published in Engineering News, Feb. 9, 1893.

Brig.-Gen. Henry M. Adams, Corps of Engineers, U. S. A., retired, died Dec. 1 while visiting in Washington, D. C. Gen. Adams was born May 8, 1844, in Massachusetts, and graduated at West Point in 1866 at the head of his class. One year after graduating, he was made an Assistant Professor of engineering at the Military Academy and served for two years in this capacity. From September, 1869, to June, 1874, he was Assistant Engineer on river and harbor work in Mississippi, Louisiana and Texas, and in 1874-'79 he was employed on a survey of the northern lakes and the Mississippi River.

In January, 1879, he was made an Assistant to the Chief of Engineers at Washington, D. C., and in 1894 he became First Assistant to the Chief of Engineers. During this period, he served on various engineer boards on river and harbor improvement, bridge construction, etc., and was a member of the Lighthouse Board in 1893-'95. In the last-named year he was also a member of the commission which reported upon the damages in connection with the raising of the Washington Aqueduct dam at Great Falls, on the Potomac.

Gen. Adams was placed in charge of various river and harbor improvements in New Jersey, Connecticut and New York, in October, 1895. Later he had charge of the fortifications of Long Island and at Sandy Hook and of the improvement of New York Harbor and the East River. He was Engineer of the Third Lighthouse District from October, 1895, to May, 1896, and in the latter year was made a member of the Board of Engineers and President of the board of engineers appointed to consider the torpedo system. During the period from 1895 to '99 he served also on a number of boards which reported on river and harbor improvement projects in the Great Lakes, New York Harbor and the Savannah River.

He attained the rank of colonel June 26, 1905, and was retired May 8, 1908, on account of age with the advanced grade of brigadier-general. At the time of his retirement, Gen. Adams was in charge of river and harbor work at Buffalo, N. Y., and was Engineer of the Tenth Lighthouse District.

Engineering Societies.

COMING MEETINGS.

ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFACTURERS.
Dec. 14-15. Annual meeting at New York City, Secy., Percy H. Wilson, Land Title Bldg., Philadelphia, Pa.

AMERICAN INSTITUTE OF ARCHITECTS.
Dec. 14-16. Annual convention at Washington, D. C. Secy., Glenn Brown, The Octagon, Washington, D. C.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.
Dec. 27-Jan. 1. Annual meeting at Boston, Mass., Secy., L. O. Howard, Smithsonian Institution, Washington, D. C.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Dec. 28-29. Annual meeting at Ames, Iowa. Secy., L. W. Chase, University of Nebraska, Lincoln, Neb.

MONTANA SOCIETY OF ENGINEERS.
Jan. 6-8. Annual meeting at Butte, Mont. Secy., Clinton H. Moore, Butte, Mont.

MICHIGAN ENGINEERING SOCIETY.
Jan. 12-14. Annual meeting at Lansing, Mich. Secy., Alba L. Holmes, 574 Wealthy Ave., Grand Rapids, Mich.

INDIANA ENGINEERING SOCIETY.
Jan. 13-15. Annual convention at Indianapolis, Ind. Secy., Chas. Brossmann, Union Trust Bldg., Indianapolis, Ind.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
Jan. 18-20. Annual meeting at New York City. Secy., W. M. Mackay, P. O. Box 1818, New York City.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 19-20. Annual meeting at New York City. Secy., Chas. W. Hunt, 220 West 57th St., New York City.

AMERICAN SOCIETY OF INSPECTORS OF PLUMBING AND SANITARY ENGINEERS.
Jan. 20-22. Annual convention at Trenton, N. J. Secy., C. S. McCosker, Mobile, Ala.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 25-27. Annual meeting at Ottawa, Ont. Secy., C. H. McLeod, 413 Dorchester St. West, Montreal, Que.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.
Jan. 26-28. Annual meeting at Cairo, Ill. Secy., E. E. R. Tratman, 1636 Monadnock Block, Chicago, Ill.

NATIONAL BRICK MANUFACTURER'S ASSOCIATION.
Feb. 7-12. Annual convention at Pittsburg, Pa. Secy., T. A. Randall, Indianapolis, Ind.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS.
Feb. 8. Annual meeting at New Haven, Conn. Secy., J. Frederick Jackson, Box 1304, New Haven, Conn.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.—The address of the Secretary was given incorrectly in the note in our issue of Dec. 2. It should be: L. W. Chase, Professor of Farm Mechanics, University of Nebraska, Lincoln, Neb.

ENGINEERING ASSOCIATION OF THE SOUTH.—The annual meeting was held at Nashville, Tenn., Nov. 22, and Mr. Geo. H. Harris, of Birmingham, Ala., was elected President. At the annual meeting of the Nashville section, held on the same date, Mr. W. H. Whorley was elected President of the section.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS.—At the annual meeting held at Lima, Ohio, Nov. 19-20, officers were elected as follows: President, O. F. Rabbe, Toledo, Ohio; Vice-President, Grant Miller, Toledo, Ohio; Secretary-Treasurer, F. E. Sanborn, Ohio State University, Columbus, Ohio; Managers, Ira Cole, Lima, Ohio; C. T. Baker, Covington, Ky.; E. M. Adams, Akron, Ohio.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—The date of the regular monthly meeting for December has been changed from the usual second Friday to the third Thursday (Dec. 16). This meeting will be held in the auditorium of the Engineering Societies' Building, 33 West 39th St., New York City, at 8 p. m., under the auspices of the High-Tension Transmission Committee. Mr. Henry L. Doherty will present a paper entitled: "Comments on Development and Operation of Hydroelectric Plants." In addition to the engineering features, this paper relates to the financing and sale of securities of power projects of all kinds, and to matters of rates, penalties, and insurance of service.

AMERICAN INSTITUTE OF ARCHITECTS.—At the 43d annual convention, Dec. 14-16, in Washington, D. C., the session for the reading of papers, apart from committee reports, will be held at 10 a. m., Dec. 16. The following papers will be read: "The Location and Treatment of Railway Stations," F. A. Delano, Chicago, Ill.; "The Relation of Railways to Conservation of Natural Resources," M. V. Richards, Washington, D. C.; "Terminal Stations," J. V. Davies and Col. J. H. Wells, of New York City; "The Relation of Buildings, Retaining Walls and Bridges, and Their Surroundings to City Development and Beauty," John R. Rockhart, New York City, in collaboration with I. D. Waterman and C. W. Lord; "Interurban Stations and Trolley Traffic in City Streets," Albert Kelsey, Philadelphia, Pa.

NEW JERSEY SANITARY ASSOCIATION.—This association, which is one of the oldest organizations of its kind in existence in America, if not the oldest, held its 34th annual meeting at Lakewood on Dec. 3 and 4. The attendance was unusually large, partly because, by direction of the State Board of Health, there was held in conjunction with the meeting of the association the annual conference of members of the State Board of Health and delegates of local boards. A considerable variety of topics relating to sanitation and to the work of boards of health was presented.

Mr. R. B. FitzRandolph, Director of the State Board of Health Laboratory at Trenton, set forth the unsanitary conditions which prevail in many establishments where food is produced and sold. He called particular attention to the fact that, although the state now has excellent comprehensive legislation in the regulation of food supplies, there is yet insufficient means for inspection to see that the laws are carried out. For instance, as was brought out in the discussion, although there are 10,000 dairies in the state which should receive state inspection at frequent intervals, there are only three inspectors available for this work, with prospects for an additional three before long.

A further and in some respects an even more striking illustration of the non-enforcement of state sanitary laws, owing to lack of appropriations and men to carry on necessary inspection work, was brought out in a paper by Dr. Harold E. Stearns, a veterinarian of Arlington, N. J. This paper was on "The Control of Animal Infection in the State of New Jersey." It showed that a very small appropriation indeed is available for the work, and that some, at least, of what is attempted is done in a shamefully incompetent manner. As an illustration of this, the author described some applications of the tuberculin test to determine whether or not cows are free from tuberculosis. Some of these tests, as made by veterinarians appointed by the state authorities, were absolutely useless. For instance, temperatures to show whether or not the cows reacted to the tuberculin test were taken in as short a period as seven seconds each.

Mr. Clyde Potts, Assoc. M. Am. Soc. C. E., of New York, read a paper on the disinfection of water and sewage, in which he reviewed progress in this line. He stated that Keyport, N. J., proposes to treat its sewage by sedimentation, followed by disinfection by chloride of lime. The final effluent will be discharged into Raritan Bay, where it might affect shellfish.

Mr. George W. Fuller, M. Am. Soc. C. E., opened the discussion on this paper. Mr. Fuller expressed himself very strongly to the effect that recent advances in disinfection by means of hypochlorite of lime, or some similar compound, marked an epoch in sewage disposal. He believed that harmful sewage bacteria may be destroyed at nominal cost. This disinfectant will not remove organic matter, nor is there any evidence to show that it will have any beneficial effect upon fish life in streams which receive sewage. The same general limitations apply to the use of this agent in water treatment. But if harmful bacteria in water supplies can be destroyed no danger to health will be left.

Prof. Earle B. Phelps, Assoc. M. Am. Soc. C. E., of Boston and New York, reinforced what Mr. Fuller had said about disinfection not being a cure-all. In approaching a sewage purification problem the first step is to learn why and what purification is needed. It may be necessary to remove bacteria alone, suspended matters alone or organic matters alone, or any two or all three of these.

Mr. H. M. Herbert, M. Am. Soc. C. E., one of the members of the New Jersey State Board of Health, thought that the studies of disinfection made by Prof. Phelps at Red Bank, N. J., for the State Sewerage Commission would save the communities of the state many thousands of dollars. [Mr. Herbert was a member of the Commission, which was recently merged with the State Board of Health.] Many of the waters of the state might safely receive sewage if it was only disinfected. Although Mr. Herbert thought that disinfection will yet be a great factor in water purification he was not so sure of its utility there as in sewage treatment.

Later on, Prof. Phelps read a paper on the sewage disposal plants of New Jersey. This state is far ahead of most others in the Union, in its number of works for sewage treatment, nearly seventy in all. In addition, it was shown by the paper and discussion following it, the number of plans for sewage works improvement by the State Board of Health, or soon to be brought before it, are some 30 in number.

Dr. Daniel D. Jackson, of New York City, presented a paper on the house fly as a carrier of disease. He reviewed the work done by himself and others in behalf of the Merchants' Association of New York City. This work shows conclusively, as the paper stated, the connection between flies and typhoid fever and diarrheal diseases in New York City. Confirmatory evidence from abroad was also cited by Dr. Jackson.

No paper presented at the convention commanded more interest than the one on the hook worm disease by Dr. Charles Wardell Stiles, of the U. S. Public Health and Marine-Hospital Service, Washington, D. C. The gross insanitary conditions prevailing in the rural districts of the South were forcibly exhibited. In many sections only a small percentage of the population has privies of any sort and such privies as are found are grossly insanitary. Soil pollution by excreta is almost everywhere present and with it the spread of the eggs of the hook worm.

A striking feature of Dr. Stiles' address was its opening remarks, to the effect that where two very unlike races or families were brought into close contact, whether among animals or men, evil effects were likely to follow. The negro and the red man have both been cut down in very large numbers by consumption, the white man's disease, while the introduction of the negro into this country is responsible for the hook worm disease. Each of these diseases has been much more fatal in its new than in its old hosts. This is particularly true of the hook worm disease, the ravages of which are much more sweeping among the whites of the South than among the negroes.

Various other papers were presented, which for obvious reasons need not be outlined here. Bare mention may be made, however, of the interesting review of the "Present Status of the Tuberculosis Campaign and Essentials for Thorough and Prompt Success," by Dr. Lawrence F. Flick, of Phipps' Institute, Philadelphia. In the course of this valuable review, Dr. Flick made it apparent that from the health-board standpoint more attention should be given to the provision of institutional care of advanced cases of tuberculosis and to the establishment of sanatoria for incipient cases. It was suggested in the discussion of this paper that, for the present at least, health authorities should direct their attention chiefly to the advanced cases, leaving to private interests the care of those in the early stages of the disease.

The Legislative Committee reported to Mr. George P. Olcott, Chairman, that of twelve bills affecting the public health, introduced in the last session of the New Jersey Legislature, ten became laws. The Committee on the Education and Training of Health Officers renewed its recommendations of previous years, that this important subject be given attention by the association and all its members.

Mr. Rudolph Hering, M. Am. Soc. C. E., of New York City, who resides at Montclair, N. J., was elected as President of the association, and Dr. James A. Exton, of Arlington, and Mr. George B. Olcott, of East Orange, were re-elected as Secretary and Treasurer respectively.

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